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A Study of Tibiofemoral angle among Healthy Female Maharashtrian Population

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Abstract
Objective: *Inspite of being clinically important, literature is scanty about* ***Tibiofemoral (TF) angle****, in Indian population and most reports are on other populations. This angle is important for correction of varus or valgus deformities by osteotomies in clinical orthopedic surgery, so present study is an attempt to formulate a baseline data of Tibiofemoral angle among healthy Maharashtrian females with reasonable accuracy, so that later on it can be compared In different regions of India.*
Materials and Method: *The current study determines the normal range of laterally opening Tibiofemoral (TF) angle among healthy Maharashtrian females. Study was conducted over 200 healthy female subjects, aged 20-50 years representing various regions of Maharashtra, a state of India, by using calibrated metallic goniometer with adjustable arms under standard conditions.*
Result & Conclusion: *The normal range of the TF angle in females is 167°- 174°. The mean TF angle in females is 170.84° with standard deviation (SD) of 1.52°.*
Keywords*: Tibiofemoral angle, female Maharashtrian population, genu varus, osteotomies.*

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I. Introduction

Existence of variations in morphological proportions in human beings has led to the development of different standards for assessing anthropometric baseline data in different populations which is undoubtedly useful in clinical orthopedic surgery. These variations lead to various studies for different parameters of human body to be set as standard data, which undoubtedly becomes base for various clinical conditions. Tibiofemoral angle (TF) or anatomical angle is formed as femur articulates with the tibia at the knee joint to form an obtuse angle, which opens laterally [1, 2, 3]. This angle results because the femoral head over hangs the shaft, hence the anatomical axes of the femur and tibia do not coincide, but form this laterally open angle [2]. This angle determines the stance and functional adequacy of the knee joint and it can be measured in a variety of ways [4, 5, 6]. This is referred to as the knee angle represented as the angle formed when two axes are drawn, one connecting the anterior superior iliac spine (ASIS) and the centre of the patella, and one between the patella and a point measured midway between the medial and lateral malleoli, [4, 6] as shown in Fig 1. The development of the Tibiofemoral angle in children has been studied and well illustrated, by Salanius and Vankka E [6]. Establishing a range of normal values is of clinical importance, as it enables the physician to determine whether the angle is within normal limits. For orthopedic surgeons knowledge of normal range of values of Tibiofemoral angle in population is essential in reconstruction and management of varus and valgus deformities [7].

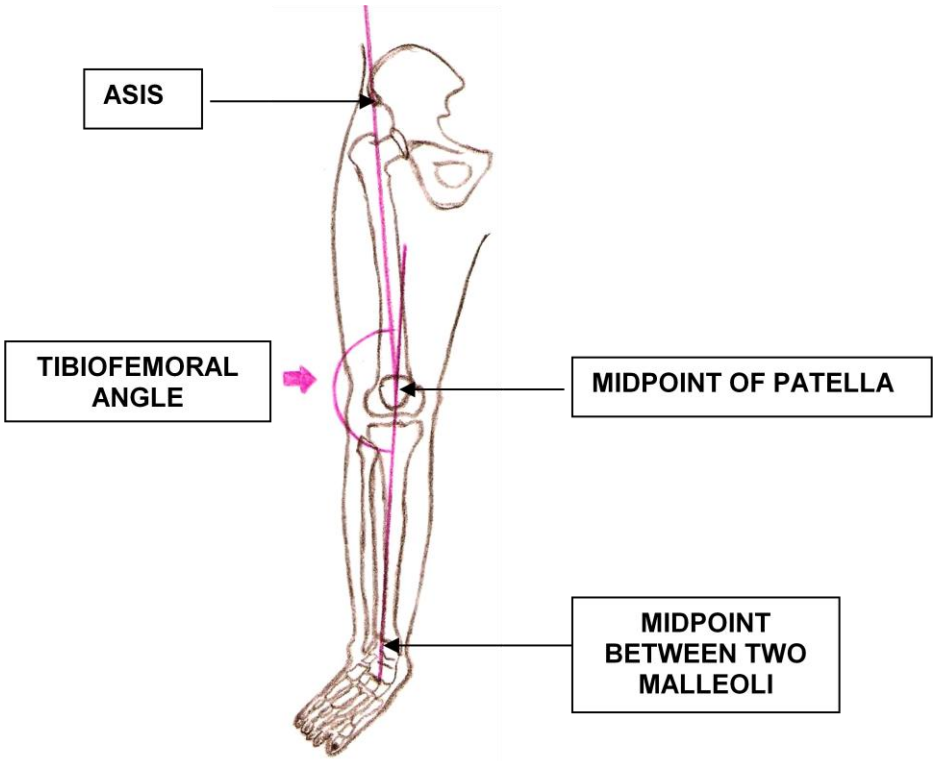

Fig 1: TIBIOFEMORAL ANGLE

In clinical practice the diagnosis of these conditions is dependent on the range of Tibiofemoral angle [7]. In genu varum (bow leg), the Tibiofemoral angle is increased where as in genu valgum (knock knee) this angle is decreased [2]. Also pre and post operative Tibiofemoral angle influence the survivorship of proximal tibial osteotomy as measured by conversion to arthroplasty and patient dissatisfaction.[8]
After cessation of epiphysial growth genu valgum can be corrected only by osteotomy [9]. Supracondylar osteotomy for valgus knees and high tibial osteotomy for varus knees.

Angular deformities are common in adults (usually bow legs in men and knock knees in women). Genu valgum may also cause abnormal tracking of the patella and predispose to patellofemoral arthritis, even in the absence of overt osteoarthritis, if the patient complains of pain, or if there are clinical or radiological signs of joint damage, a'prophylactic' osteotomy is justified: above the knee for valgus deformity and below the knee for varus [10].

Approximately above 20 yrs, epiphysial growth of extremities bones completes. In this study we have included population more than 19 yrs of age, so that normal variations due to epiphysial growth of bones can be excluded and we can calculate a normal range of Tibiofemoral angle using a goniometer [11] among a sample of Maharashtrian subjects, which can be applied to Maharashtrian population.

In a population with an Asian living habits (i.e. the habit of squatting and sitting cross-legged), the knee is involved more commonly, while in a population with western living habits, the hip joint is more commonly involved in osteoarthritis [12].

Despite the clinical importance of Tibiofemoral angle, literature is scanty in Indian population and most reports are on other populations. In clinical orthopedic surgery, for correction of varus or valgus deformity by osteotomies, this angle is important, so present study is an attempt to formulate a baseline data of Tibiofemoral angle among healthy Maharashtrian population with reasonable accuracy.

Aim: Present study aims at determining the range of normal values of Tibiofemoral angle among healthy Maharashtrian females.

II. Material and Methods

This series includes 200 healthy female subjects representing various regions of Maharashtra. Female subjects were randomly selected relatives of army personnel from the Maratha regiment, Aundha, Pune. All are natives of Maharashtra, belonging to the different regions of Maharashtra. All the subjects were explained about the purpose of study before taking the measurements. Study was conducted in Military cantonment, Aundha, Pune.

The subjects were healthy. Subjects with any history of joint injuries or musculoskeletal dysfunction of lower limbs; any bony deformity, joint disease or pathology (pain, swelling) in lower limb; any history of fracture and its surgical intervention in the lower limb (concerning knee joint, femur, tibia, patella were excluded from the study. Tibiofemoral angle (in degrees) was measured using standardized method using a calibrated metallic goniometer with adjustable arms [11] as shown in **Fig 2**.

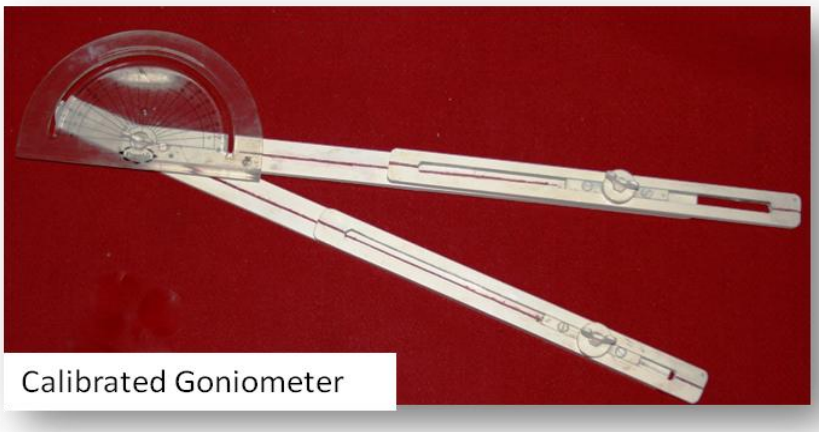

Fig 2: Calibrated metallic goniometer with adjustable arms

The angle was measured in two positions (Standing and Supine) of the body. Three points were marked –
1. Anterior superior iliac spine (ASIS),
2. Midpoint of patella and
3. Midpoint between the medial and lateral malleoli,

1. **Supine** position, subject lies straight, with either the medial aspect of knees or the feet together and feet were straight. Similarly, the extremity was positioned with the patella straight ahead and the lateral angle between two lines, one line connecting anterior superior iliac spine and midpoint of patella, and the other line between patella and midpoint between the medial and lateral malleoli, of both lower extremities was measured using calibrated goniometer. The two adjustable arms of goniometer were placed on these two lines. Laterally open angle was measured first on right side and then on left side, as shown in **Fig 3**.

2. **Standing** position - The subject stands erect, eyes facing straight, with either the medial aspect of knees or the feet together. The extremity was positioned with the patella straight ahead.The lateral angle between two lines, one line connecting anterior superior iliac spine and mid point of patella, and the other line between patella and midpoint between the medial and lateral malleoli, of both lower extremities was measured in similar manner, as shown in **Fig 4.**

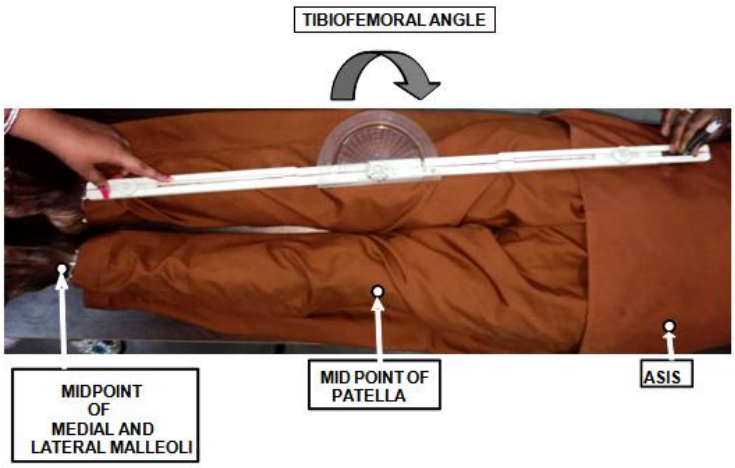

Fig 3: Tibiofemoral angle in supine position with reference points

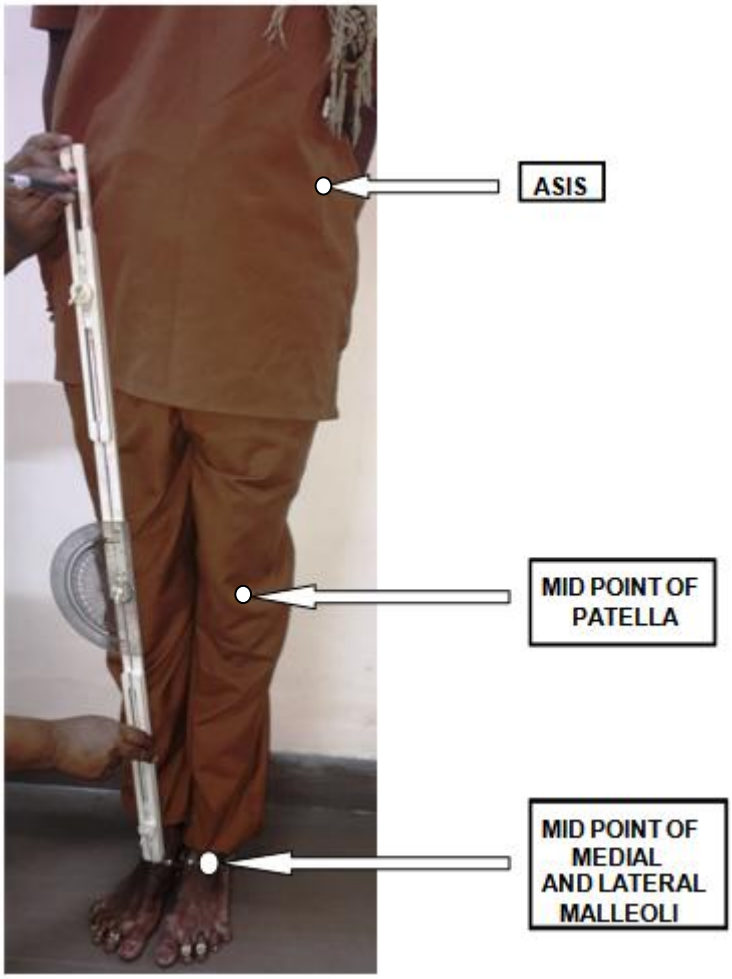

Fig 4: Tibiofemoral angle in standing position with reference points

Observation and Results

Descriptive statistics i.e. mean, standard deviation and normal range of the angle were calculated. All the data has been calculated taking due care of intraobserver, interobserver variations. Results were processed by computer and statistical analysis gave the normal range, means & standard deviations of the values of Tibiofemoral angle in females as shown in **Table 1,2,3** and tables represented in **Fig 5,6,7**

Table 1: Mean and Standard Deviation of the Tibiofemoral angles of both sides and positions in female subjects.

	GENDER	**MEAN (in degrees)**	**STANDARD DEVIATION (SD in degrees)**
Right Supine TF Angle	F	170.82	1.65
Left Supine TF angle	F	170.99	1.51
Right Standing TF angle	F	170.89	1.47
Left Standing TF angle	F	170.66	1.45

Represented in **Fig 5**

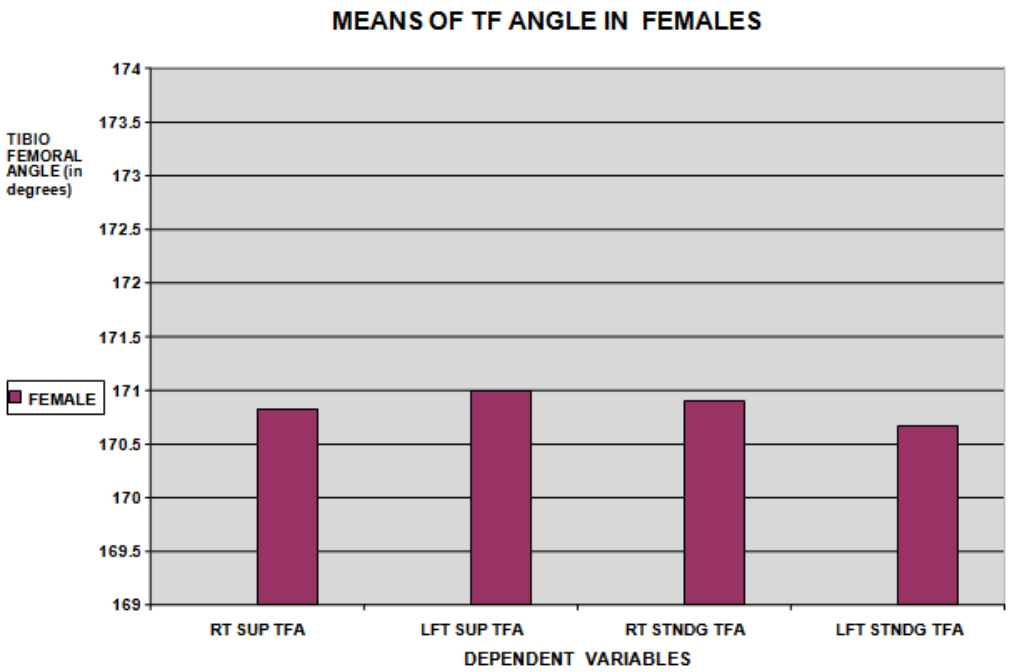

Fig 5: Means of Tibiofemoral angle in females

Table 2: Mean of the Tibiofemoral angles in females with respect to different age groups

AGE GROUPS (years)	MEAN OF TIBIOFEMORAL ANGLE IN FEMALES (in degrees)			
	RIGHT SUPINE	**LEFT SUPINE**	**RIGHT STANDING**	**LEFT STANDING**
20 -29	**170.83**	**170.96**	**171.01**	**170.69**
30-39	**170.81**	**171.09**	**170.58**	**170.58**
40-49	**171.00**	**170.60**	**171.20**	**170.80**

Represented in **Fig 6**

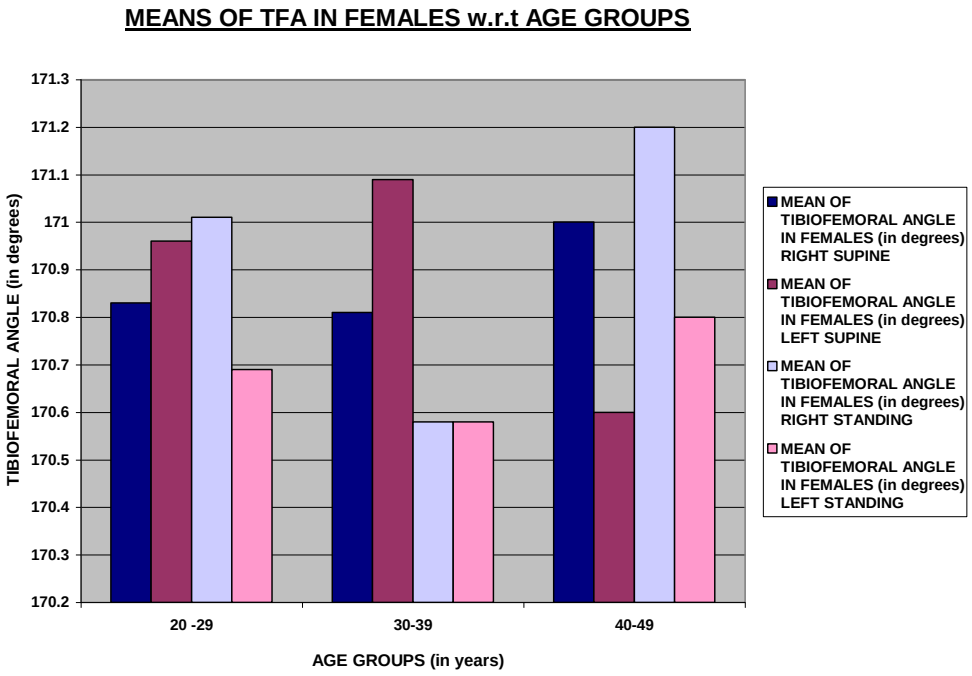

Fig 6: Mean of Tibiofemoral angle in males with respect to different age groups

Table no. 3: Mean of the Tibiofemoral angles in females with respect to different divisions of Maharashtra

DIVISIONS OF MAHARASHTRA	MEAN OF TIBIOFEMORAL ANGLE IN FEMALES(in degrees)			
	RIGHT SUPINE	**LEFT SUPINE**	**RIGHT STANDING**	**LEFT STANDING**
DESH	**170.90**	**170.79**	**170.82**	**170.59**
KHANDESH	**171.25**	**171.08**	**171.28**	**170.73**
KONKAN	**170.37**	**171.57**	**170.65**	**170.61**
MARATHWADA	**170.89**	**170.89**	**171.21**	**170.93**
VIDARBHA	**171.12**	**170.94**	**170.44**	**170.25**

Represented in **Fig 7**

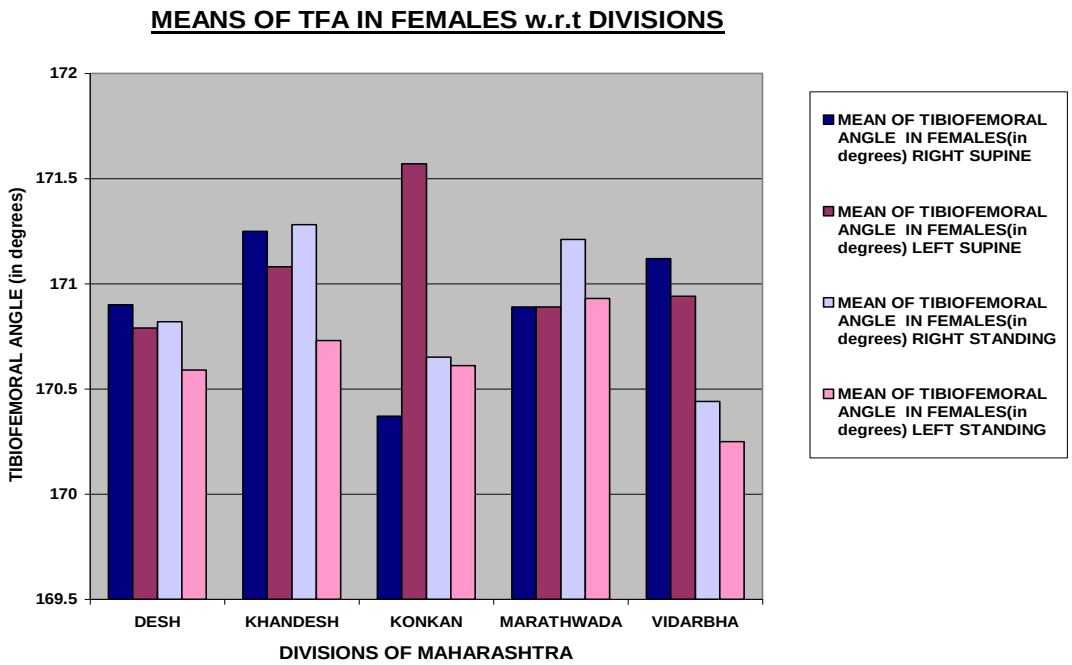

Fig 7 : Means of Tibiofemoral angle in females with respect to divisions

III. Discussion

By this study, we have studied Tibiofemoral angle, among healthy Maharashtrian females aged between 20 to 50 years. Literature regarding Tibiofemoral angle measurement in Indian adult female populations is scanty and most reports are on Caucasians [2,3,4,9,10] ; Chinese [14,15] Japanese [16,17,18] ; and Africans (Kenyans, Tanzanians, Ugandans & Malawians). [1, 7]. In Caucasians the range of Tibiofemoral angle is between 170-175° [19]. Genu valgum is said to occur when the angle is less than 165° in Caucasians of both genders; if the angle is greater than 175°, genu varum occurs and both conditions predispose the knee to overload. [7, 20]. In African subjects, Igbigbi and Kwatampora, (1997) the mean tibiofemoral angle in Kenyan females was 174.00 with standard deviation (SD) of 2.31°. Similarly in Tanzanians mean tibiofemoral angle in females was 175.15 with standard deviation (SD) of 1.56° [1].

Igbigbi and Msamati (2002) found mean tibiofemoral angle in adult black Malawian females was 174.46 with standard deviation (SD) of 4.30°, The range of the angle for both genders was 164-185°.[7]

Comparison of present study values with previous studies

The mean tibiofemoral angle in Kenyan females was 174.00 with SD of 2.31° [1]
In Tanzanians mean tibiofemoral angle in females was 175.15 with SD of 1.56°. [1]
In Malawians mean tibiofemoral angle in females was 174.46 with SD 4.30° [7].
In Maharashtrians, according to our present study, the mean value of Tibiofemoral angle in females is 170.84° with SD 1.52°. Normal range of this angle in Maharashtrian females came out to be between 167°-174°.

This data has been tabulated in **table no. 4.**

Table no. 4 : Comparison of present study values of Tibiofemoral angle in females with previous studies (as per references given in text)

TIBIOFEMORAL ANGLE	GENDER	MEAN (in degrees)	STANDARD DEVIATION (in degrees)
Chinese population	Females	177.8°	2.5°
Kenyan population	Females	174.00°	2.31°
Tanzanian population	Females	175.15°	1.56°
Malawian population	Females	174.46°	4.30°
Maharashtrian population (present study)	Females	170.84°	1.52°

Although there are some limitations of this study, that sample size is limited only to two hundred individuals, but it has a lot of further scope for research in this field especially in Indian population. Survey on a large scale can be undertaken using these measurements and further detailed interactions can be predicted between different populations.

IV. Conclusion

Measurements of Tibiofemoral angle have been used for correcting varus and valgus deformities at knee in adults in orthopedic clinics. Hence it is important to establish a normal mean, standard deviation and range of tibiofemoral angle for different populations.

Our study establishes that normal range of the Tibiofemoral angle in females is 167°-174°. The mean TF angle in females is 170.84° with standard deviation (SD) of 1.52°.

In this study, we found there is no significant difference in the angle, according to different age groups, divisions of Maharashtra, side and positioning of the body in female Maharashtrian population.

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