Angular Profile of the Knees of Nigerian Children in Lagos, Nigeria

Odatuwa-Omagbemi DO,[1] Odunubi OO[2] & Ugwoegbulem OA[2]

ABSTRACT

Introduction: Angular misalignments of the knees in children are common in our environment. Many of these variations fall within normal limits. Only a few will require further investigations and treatment.

During normal growth, physiological changes occur in the angle of the knees as the child grows. This phenomenon has been investigated and documented by scholars in different environments. Some similarities and differences have been noted between children of different races and environments by various authors.

Aim: This study strives to investigate the presence or absence of these findings in Nigerian children and provide local reference data to aid management of similar cases in our environment.

Methodology: The clinical methods of assessment of knee angles were used in this study. Six hundred children aged 3-8 years (age last birthday) were selected from public and private nursery/primary schools in Lagos metropolis and had their tibiofemoral angles measured with a goniometer and their intercondylar/intermalleolar distances measured with an inextensible tape rule.

Results: The 600 children were divided into six age groups for the purpose data collation and analysis. The mean tibiofemoral angle for the six age groups was 6.0 + 8.1°. A valgus inclination of 8.4 + 7.2° was noted at 3 years of age which decreased to 3.4 + 8.6° at 8 years of age. The intercondylar/intermalleolar distance was 2.5 + 3.4cm at age 3 years and 0.7 + 3.3cm at 8 years of age. The tibiofemoral angle was found to be quite correlated with the intercondylar/inermalleolar distances with a correlation coefficient of r=0.765.

Conclusion: Compared with figures from previous similar studies in other places, most of the parameters show similar pattern of changes with growth but the degree and timing of the changes show some basic differences attributable to racial/genetic factors, methods of measurements and other environmental factors. Figures gotten in this study is of use for clinical reference when similar cases present in our clinics in this this sub-region .

Keywords: *Angular Profiles, Nigerian Children, Knees, Orthopaedic*

Correspondence: *Odatuwa-Omagbemi DO, Department of surgery, Delta State University, Abraka, Nigeria.*

[1]Department of Surgery, Delta State University, Abraka, Nigeria. [2]Department of Orthopedics and Traumatology, National Hospital, Igbobi, Lagos .

Introduction

Children presenting with perceived angular problems of the knees are common in our clinics. The usual presentation is either that of bow legs or knock knees.[1,2,3,4]

The tibiofemoral angle varies widely between individuals and within the same individual child with growth. Many authors both national and international have shown that at birth, the knees

are in marked varus [1,2,3,5,6] . This tends to change to 0o at the age of about 11/2 to 2 years. At 3 to 31/2 years, the knees change to maximum valgus, and with further growth, the valgus inclination tend to gradually correct itself[1,2,3,5,6] . The adult value is usually attained at the age of about 9-10 years, with only a minimal further change after this age.[1,2,3,5,6] Some local variations in the degree of these changes in children from different racial, genetic and environmental back grounds have nevertheless also been highlighted by some authors[1256789], hence the need to obtain local reference figures.

A knowledge of these changes is necessary to enable the attending Physician differentiate these normal physiological variations which usually will not need treatment, from pathological conditions that will need further investigations and treatment.

Various methods including: radiologic, photographic, clinical or a combination of methods have been used by different authors in their studies.[1,2,5,6-16] The clinical method was used in this study because, it is cheap, harmless and can be routinely used in our clinics.

This study aims to provide local reference figures for the age group and parameters measured for routine clinical use by Orthopaedic surgeons and other physicians who care for children with similar presentation. Any notable differences and similarities between findings here and previous national and international studies will be appropriately stressed for better overall patient management.

Subjects, Materials and Methods: This cross-sectional descriptive study involved the measurement of:

1. The tibiofemoral angles,
2. The intercondylar/intermalleolar distances of 600 asymptomatic Nigerian children (1200 lower limbs) residing in Lagos .

Two local government council areas were selected by balloting system of random sampling.17,18 The list of private and public nursery/primary schools in the selected council areas were obtained from the Local Government Education Authorities (LGEA) where consent was also obtained. From the list of schools, systematic random sampling was used to select 12 schools (6 private and 6 public).17,18 At the selected schools, a list of children that fell within the study age group arranged in alphabetical order using their surnames was obtained after taking consent form the school authorities and PTAs (Parents/Teachers Association).Verbal ascent was also obtained from each child before taking measurements. The lists were used as sampling frames to select 50 children from each of the 12 schools to give a total of 600 children. All measurements were done by the first author. Intra-observer variation was assessed by measuring the above parameters repeatedly in six children (aged 3, 4, 5, 6, 7 & 8 years) alternate daily for 2 weeks. The average standard deviations were: 2.1o and 0.4cm for tibiofemoral angle and intermalleolar/intercondylar distances respectively.

Measurement of Tibiofemoral Angle, Intercondylar/Intermalleolar Distances.

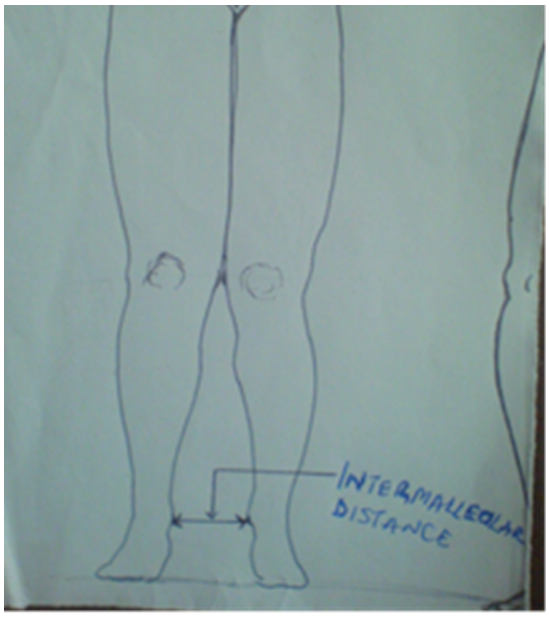
The methods used by Cheng *et al*[2] and also, Arazi *et al*[14] were used in this study. The child in under pants with lower limbs exposed from groin down (a male or female chaperon being present as applicable) was made to stand erect with the hips in neutral position and the knees fully extended with patellae pointing forward. The knees and the ankles were positioned with the condyles or malleoli touching each other for valgus or varus inclinations respectively. The axis of the femora (up to the mid-thigh) and tibiae (down to the mid-ankle) were palpated and marked with a skin marker on the skin. The centre of the patella is also marked on the skin. A standard goniometer (

with attached extensible arms) is centred on the patella and used to measure the tibiofemoral with arms directed along the tibial and femoral axes as previously marked out on the skin for each limb. Varus angles were recorded as positive (+) angles while valgus angle are recorded as negative (-) angles.

In the same position, the intercondylar (IC) and intermalleolar (IM) distances were measured with an inextensible tape rule and recorded in centimetres as positive (+) or negative (-) values respectively. See, pic.1-4.

Pic. 1. *Position and Skin Marking For Measurement Of Tibiofemoral Angle And IC/IM Distances*

Picture 2. *Measurement of Tibiofemoral Angle*



Picture 3. *Intermalleolar (IM) Distance*

Picture 4. *Intercondylar (IC) Distance*

Data Handling

The subjects were divided into six different age groups. The Statistical Package for Social Sciences (SPSS) version 15 software was used for data handling and analysis.

In all statistical tests, the null hypothesis was rejected at $P<0.05$.

Results

Six hundred children aged 3-8 years were studied giving a total of 1200 limbs. Of this number, 311 were females and 289 were males. The age/sex distribution is shown in table 1. and the bar chart (fig. 1).

Tibiofemoral Angle: A maximum valgus angle of 8.4+7.2o was observed at age 3 years. This gradually decreased to 3.4+8.6o at the age of 8 years of age. Of the 600 children, only 1 varus inclination was observed at age 3 years, 4 were observed at 4 years, 3 at 5 years, 9 at six years, 13 at 7 years and the highest number of 20 at 8 years of age giving a total of 50 children (8%) with varus angles. Table 2. shows mean tibiofemoral angle values for the six age groups +2SD (2 Standard deviations). The graph in *fig. 2* also depicts the progression.

A comparison of the mean values for the tibiofemoral angles in the age groups between left

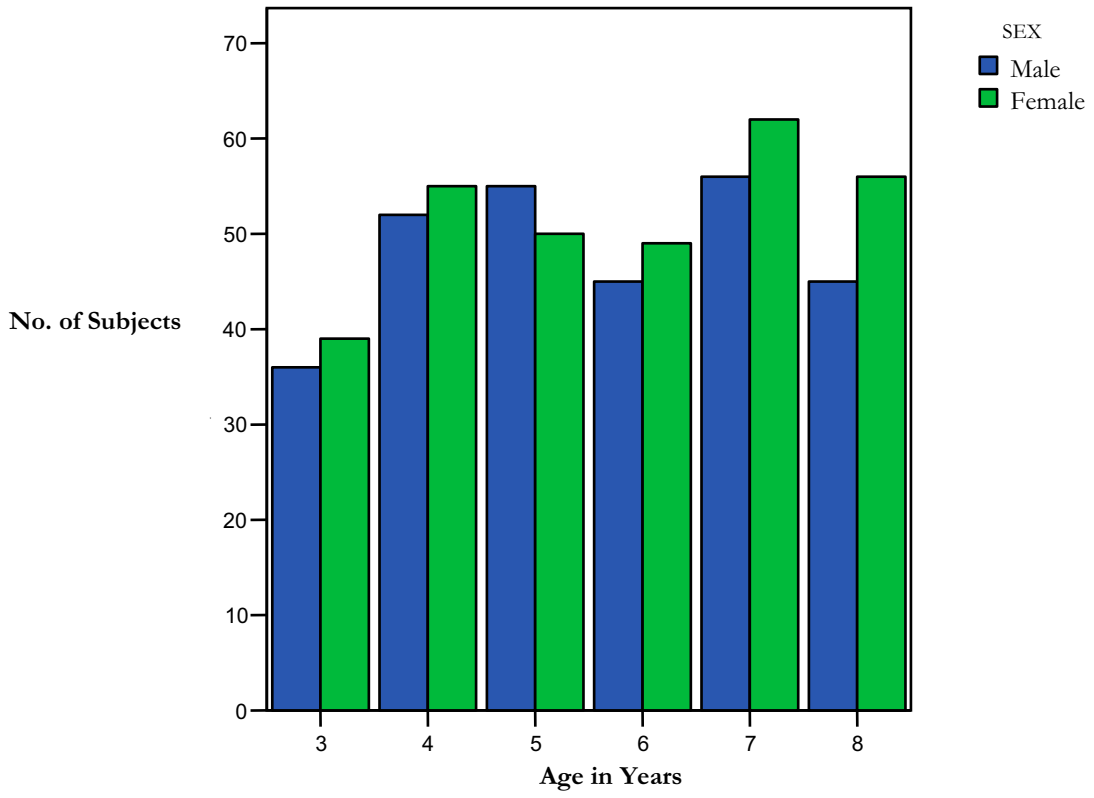


Figure 1: *Bar Chart Showing Frequency Distribution, Age and Sex*

Table 1: *Age in Years/Sex Cross Tabulation*

	SEX		Total
Age In Years	**Male**	**Female**	
3	36	39	75
4	52	55	107
5	55	50	105
6	45	49	94
7	56	62	118
8	45	56	101
Total	289	311	600

Table 2: *Mean Tibiofemoral Angle± 2SD (Rt. & Lt. Combined)*

AGE IN YEARS	MEAN TF ANGLE	MEAN +2SD	MEAN -2SD
3	-8.4	-1.3	-15.6
4	-7.7	-1.1	-14.4
5	-6.5	0.2	-13.1
6	-5.1	2.2	-12.3
7	-5.2	2.5	-13.0
8	-3.3	5.2	-12.0

Table 3: *Mean Tibiofemoral Angle for Right and Left in the Ages Studied*

AGE IN YEARS	MEAN TF ANGLE(RT)	MEAN TF ANGLE(LT)
3	-8.4	-8.50
4	-7.7	-7.7
5	-6.4	-6.5
6	-5.0	-5.0
7	-5.2	-5.3
8	-3.3	-3.5

and right lower limbs did not show any appreciable difference between the two lower limbs. (Table. 3) although, in most of the age groups, the mean for the left tended to show more valgus inclination than the right. However, application of the t-test to the raw data showed a significant difference between the values from the right lower limb and that form the left lower limb ($P<0.027$) indicating that even in normal individuals, the limbs are not exact mirror images

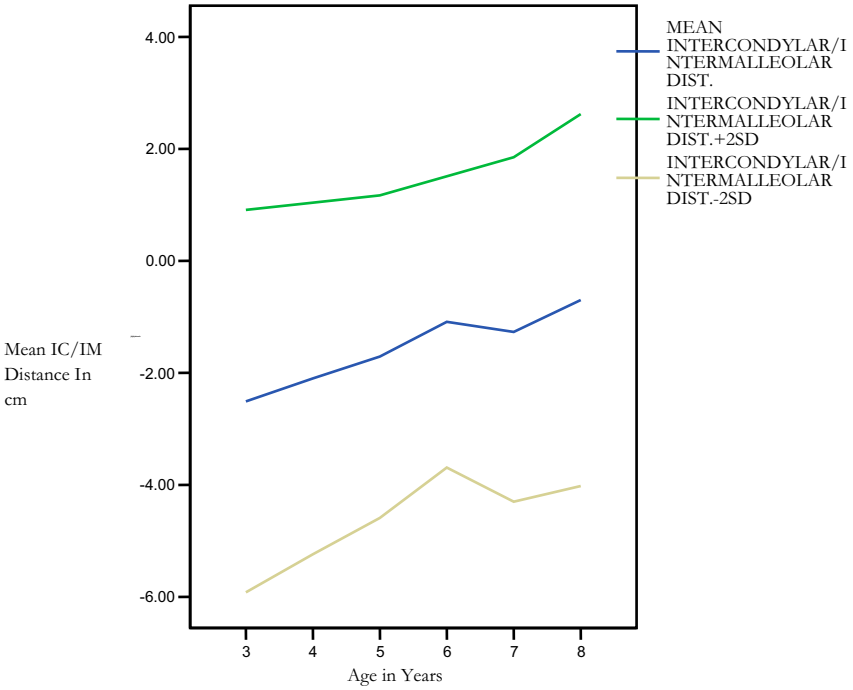


Figure 3: *Mean Intercondylar/Intermalleolar (IC/IM) Distance ± 2SD Versus Age in Years*

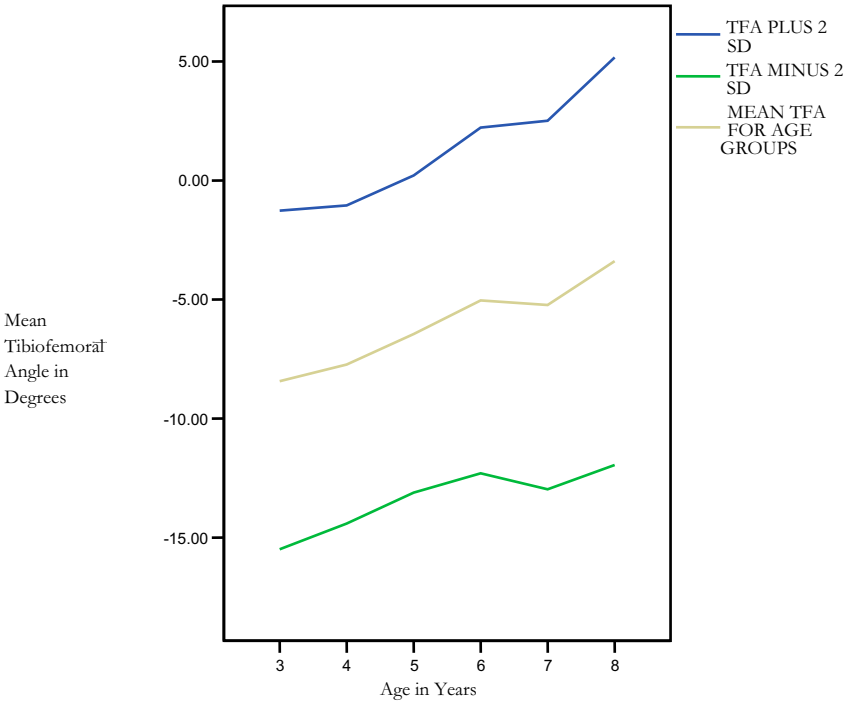


Figure 2: *Mean Tibiofemoral Angle in Degrees Versus Age in Years.*

of each other. Values from both lower limbs nevertheless showed a very high degree of correlation (r=0.971) hence the use of the mean value of the tibiofemoral angles from both limbs for most of the computing.

Intercondylar (IC)/intermalleolar (IM) Distances: The maximum mean intermalleolar distance of 2.5+3.4cm was observed at age 3 years. This decreased gradually to a valgus of 0.7+3.33cm at 8 years of age.

The values for the ages + 2SD are as displayed in the graph in *fig.3*. The IC/IM distance was further confirmed in this study to be highly correlated to the tibiofemoral angle with a correlation coefficient of r=0.765. P<0.0001.

Discussion

Complains of angular problems of knees in children are common in our clinics. Many researchers both national and international have through their publications shown that most of these perceived problems are normal variations with growth that would not necessarily need treatment. The knee angle has been reported to be of varus inclination at birth, neutral at 18-24 months and of maximum valgus at 3-4 years of age followed by a less dramatic reduction to a lesser degree of valgus in adult life.[2,4,5,6,7,8,10,12,14,15,16,19,20].

In this study, a maximum valgus tibiofemoral angle was observed at the age of 3 years (8.4+7.2°).

Badru6 and Oginni *et al*[7], Cheng *et al*[2], and Selenius and Vankka[5] also reported similar findings in their studies.

Badru6 and Oginni *et al*[7] in Ilesha, reported a valgus inclination of the knees of 7.1+1.7° at age 3 years while Cheng *et al*[2] reported a maximum valgus inclination of 8° in Chinese children at 3.5 years of age. Selenius and Vankka[5] on the other hand, found a maximum valgus of 10-11° at 3-4 years in Finnish children. In contrast, Arazi *et al*[14] reported a maximum valgus of 11° at ages 6 and 7 years for boys and girls respectively in Turkish children while Omololu *et al*[8] in Ibadan reported a constant valgus angle of 11° at ages 1-10 years. It is important to note that while in most other studies including this one both varus and valgus angles were computed together, Omololu *et al* computed the two separately making comparison of their findings with other results difficult.

At 8 years old, the valgus angle in this study has decreased to 3.4+8.6°. Badru6 and Cheng *et al*[2] reported a valgus angles of 5.5° and 1° respectively in the same age group in their studies.

Most authors did not report differences between the right and the left lower limbs as recorded in this study. However, Oginni *et al*[17] noted that the left showed 1o more valgus than the right. That the two limb are not exact mirror images of each other is also obvious in the monogram in the publication of Omololu *et al*[8]. The left showed more valgus in this study. It is nevertheless pertinent to note that method s of measurements, the precision of such measurements and observer variations may contribute to the observed differences.

The intercondylar/intermalleolar distance has been reported by various authors to be well correlated with the tibiofemoral angle and has been suggested by many as an alternative way of indirectly assessing knee angles.[2,5,6.8,9,12,14].

A mean intermalleolar (valgus) distance of 2.5+3.4cm at 3 years of age which decreased to 0.7+3.3cm at 8 years was observed in this study. Cheng *et al*[2] observed an intermalleolar distance of 2.8cm at 3 years which decreased to 0+3cm at 8 years of age.

A combined (for both sexes) correlation coefficient of r=0.765 between the IC/IM distance and the tibiofemoral (TF) was found in this study. Cheng *et al*[2] reported a value of r=0.71

for boys and r=0.74 for girls in Chinese children while Harcourt reported a coefficient of r=0.77 in Enugu and Cahuzac *et al*[12] found r=0.82 and r=0.74 for boys and girls respectively in European children. A lower degree of correlation was recorded by Arazi *et al*[14] in Turkish children (r=0.40for boys and r=0.43 for girls).

Different views have been expressed on which of the two parameters to use routinely in the assessment of knee angles in our clinics. While Cheng *et al*[2] feel that the IC/IM distance is simple and quite reliable and thus should be the one used routinely, Arazi *et al*[14] and Cahuzac *et al*[9], feel otherwise (i e, TF angle should not be used). From this study, one would rather opine that both parameters are good for assessing physiological variations in which the deformities are largely symmetrical. The use of IC/IM becomes unreliable when deformities are not symmetrical, unilateral and of course in wind swept deformities.

Conclusion

Like most previous studies, this study has further confirmed that children during normal growth display physiological variations in their knee angles. Here, the Nigerian children exhibited a maximum valgus tibiofemoral angle at 3 years of age that gradually decreased with age as alluded some previous authors too. The intercondylar/intermalleolar distance also showed a similar trend in this study and the highly significant correlation between it and the tibiofemoral angle was also apparent here. Also this study revealed further that some minor differences in the value of the measured parameters between the right and the left lower limbs can occur even in normal individuals.

The values of the parameters obtained in Nigerian children in this study showed some basic similarities and differences between them and children of other races and environments which need to be borne in mind by Orthopaedists and other physicians caring for children in this sub-region.

References

1. Sass P, Hassan G. Lower extremity abnormalities in children. Am. Fam. Physician 2003; 68:461-468.
2. Cheng JCY, Chan PS, Chiang SC, Hui PW. Angular and rotational profile of the lower limb in 2630 Chinese children. J. Paediatr. Orthop 1991; 11: 154-161.
3. Solomon S, Warwick D, Nagayam S. Appley's system of Orthopaedics and fractures. 8th ed, London; Edward Arnold. 2001; 449-484.
4. Chapman MW. (Ed). Chapman's Orthopaedic surgery. 2nd ed. Philadelphia, J.B. Lipincot. Co; 1996; 1345-1357.
5. Salenius P, Vankka E. Tibiofemoral angle in children. J. Bone Joint Surg 1975; 57-A: 259-261.
6. Badru OS. Changes in knee angles in Nigerian Children with growth. Part II Dissertation (FMCS) to the National Postgraduate Medical College of Nigeria. May, 2000; 1-42. (Unpublished)
7. Oginni LM, Badru OS, Sharp CA, Davie MWJ, Worsfold M. Knee angles and rickets in Nigerian children. J Paediatr. Orthop. 2004; 24: 403-407.
8. Omololu B, Tella A, Ogunsola SO, Adeyemo AA, Adebisi A, Alonge TO, et al. Normal values of knee angle, intercondylar and intermalleolar distances in Nigerian children. West Afr J Med 2003; 22: 301-304.
9. Harcourt SL. Clinical assessment of tibiofemoral Angle in children 4-7 years of age in Enugu. Part II Dissertation (FMCS) to the National Postgraduate Medical College of Nigeria May,2004; 1-46. (Unpublished).

10. Solagberu BA. Angular deformities of the knee in children. The Nigerian Journal of Surgical Research 2000; 2: 62-67.
11. Salawu SAI. Knock knee and bow leg in Zaria. Orient Journal of Medicine 1992; 4: 69-72.
12. Cahuzac JPH, Vardon D, De Gauzy JS. Development of clinical tibiofemoral angle in normal adolescents. J. Bone Joint Surg 1995; 77-B: 729-732.
13. Smyth EHJ. Windswept Deformity. J. Bone Joint Surg 1980; 62-B: 166-167.
14. Arazi M, Ogun TC, Memik R. Normal development of tibiofemoral angle in children: A clinical study of 590 normal subjects from 3-17 years of age. J. Paediatr. Orthop 2001; 21: 264-267.
15. Heath CH, Staheli LT. Normal limits of knee angle in white children-genu varum and valgum. J. Paediatr. Orthop 1993; 13: 259-262.
16. Bohm M. Infantile deformities of the knee and hip. J. Bone Joint Surg 1933; 15-A: 574-578.
17. Araoye MO, Research methodology with statistics for health and social sciences., 1st ed.,Ilorin, Nathadex Publishers . 2003;130-258.
18. Bankole MA(ed). Handbook of research methods in Medicine. Lagos, Nigerain Educational Research & Development Council 1991; 127-211.
19. Knight RA. Developmental deformities of the lower extremities. J. Bone Joint Surg 1954; 36-A: 521-527.
20. Levine AM, Drennan JC. Physiological bowing and tibia vara: The metaphyseal-diaphyseal angle in the measurement of bowleg deformities. J. Bone Joint Surg 1982; 64-A: 1158-1162.