Original Research Article

TITLE: Prevalence and degree of Lower Limb Inequality in asymptomatic young adult Nigerians.

Running Title: Lower limb Inequality

ABSTRACT

Objective: The development of right and left lower limbs start at the same time and subsequent serial growth occurs simultaneously however at adulthood, small but usually functionally negligible differences exist in their lengths. This study set out to find out the prevalence and degree of lower limb length inequality (LLI) amongst young adult Nigerians with grossly normal lower limbs.

Methods*:* Full length and segmental lengths of one hundred and three healthy young adult Nigerians of different ethnic groups were measured using the direct clinical method.

Results: The overall prevalence of LLI was 89.3% while the rate for male and female was 96.2 % and 82.4 % respectively. The LLI range was 0.5-2.5cm with majority being less than 2.0cm. The LLI was significantly higher in male (1.18±0.83 vs 0.75±0.60 cm). Side for side, the male limb is significantly longer than that of the female. The thigh girth was significantly wider in the female while there was no difference in the leg girth between male and female. The males were found to be significantly taller than the females. Comparison of the results amongst the major ethnic groups enrolled in the study did not reveal significance difference

Conclusion: Anatomical lower limb inequality is very common amongst young adult Nigerians without any gross musculoskeletal but it is not obvious

Key words: Lower limb length inequality, Young adult Nigerians, Prevalence and degree.

1.INTRODUCTION

The limb bud primordia appear at the end of the fourth week as small elevations of the ventrolateral body wall, however most of the development occurs in week 6. The lower limb buds are formed by a series of reciprocal inductions of mesoderm and ectoderm. The lateral somatopleuric mesoderm induces a transitory longitudinal thickening of the surface ectoderm, the wolffian crest, a fold that can be seen in front of the somite column. There is rapid disappearance of the middle portion of the column leaving only two nodules at the extremities of the crest which are at the level of the future bony pectoral and pelvic girdles. The lower limb buds develop opposite the lumbar and upper sacral segments.

The ectodermal nodule or apical ectoderm ridge, located of the proximal side of the column, induces the mesenchyme to grow and develop the limbs in successive waves. Thus each bud is initially a mass of mesenchyme of somatic mesodermal origin covered by ectoderm.

The distal ends of the lower limb buds flatten into paddle shaped foot plates with the toes forming at the margins of the plates.[1]

The human bipedal gait is premised on the organization of the lower limb coupled with its musculoskeletal adaptations [2-4]. Human morphology is a product of its developmental biology thus any alteration or disturbance of the development processes will affect the morphology that may be accompanied with structural and or functional consequence.

Areas in which lower limb length are being applied include ergonomics, height estimation, sex determination and production of leg prostheses.

Lower limb length inequality also known as Leg length inequality (LLI) may be congenital or acquired, symptomatic or asymptomatic. Most of the available studies on the prevalence of leg length inequality were done in patients [5-11] and only one in volunteers [12]. In a systemic review of the prevalence of LLI, it was found that 90 % of normal population had some variance in lower limb length with 20 % having a difference of more than 9mm [13]. All these studies employed radiological measurements and largely in patients with symptomatic leg length discrepancy and in non-Africans. Thus the need to do a direct measurement approach in Africans (non-symptomatic Nigerians to be specific) is pertinent hence the desirability of this study.

2.MATERIALS and METHODS

2.1 Demographics of the study population

One hundred and three healthy young adult Nigerians undergraduate and graduate students of the University of Ibadan without any obvious lower limb abnormality were enlisted for the study. Inclusion criteria included being of independent mobility and normal gait pattern. While volunteers with previous lower limb fractures or past history of lower limb orthpaedic procedures were excluded. The recruitment of the participants (subjects) was by a modified snowball sampling technique following an initial systematic random sampling of faculties and departments. Approval for the study was granted by the University of Ibadan / University College Hospital Research Ethics Committee. Only participants whose parents are of same ethnicity were enrolled for the study. Informed consent was sought and obtained from each participant and none was either coerced or gratified. Also, the participants were informed of the risks and benefits of the study.

2.2 Anthropometric measurements, data analysis and processing

The enlisted participants were assessed in batches. Eleven direct measurements of the both lower limbs were taken in each subject. These measurements were; apparent lower limb length, real lower limb length, femur length, tibia length, fibula length, foot length, calcaneal length, thigh girth and leg girth. Reference points for these measurements were bony landmarks as approved in the Integrative Measurement Protocol Morphological and Behavioral Research in Human and non- human primates version 1.0 were used [14]. The landmarks of various measurements are as follow:

i) Real lower limb length = distance between the anterior superior iliac spine and the epicentre of the medial malleolus.
ii) Apparent lower limb length = distance between the umbilicus and the epicentre of the medial malleolus
iii) Femur length = distance between the epicentres of the greater trochanter and the lateral femoral epicondyle.
iv)Tibial length= distance the epicentres of the medial condyle and the medial malleolus.
v) Fibular length= distance between the epicentres of the fibular head and the lateral malleolus.
vi) Foot length= from the base of the heel to the tip of the hallux.
vii) Calcaneal height =distance between the insertion of the calcaneal tendon and the heal base.
viii) Thigh girth= thigh circumference taken at three points 15cm, 25cm and 35cm proximal to the base of the patella
ix) Leg girth= leg circumference measured at three points 12cm, 22cm and 32cm above the epicentre of the medial malleolus.

All these measurements were taken by means of a non-elastic fibre tape graduated in centimetres and metres with the subject in the anatomical position and by the same researcher thus eliminating inter observer error. Each parameter was taken thrice and the average recorded. The dignity of each subject was strictly ensured and there was no undue exposure. Height was measured by means of a standard stadiometer to the approximate centimetre. The results were analyzed with SPSS version 22 and expressed as means and level of significance determined with student t- test and set at $P \leq 0.05$

3.RESULTS

One hundred and three adult Nigerians with mean age of 27.60 ± 2.72 years and a range of 25-38 years were recruited into and completed the study. The males were 48.5 % (n = 50) of the study population with a mean age of 27.96 ±2.60 years while the females accounted for 51.5 % (n = 53) having a mean age of 27.23 ± 2.80 years. Thus, both genders were of same age group The male subjects had a significantly greater height of 1.73 ± 0.09 metres than the female subjects (1.63±0.07 m). The subjects were from eleven ethnic groups with the three largest groups being Yoruba (58), Igbo (18) and Edo (9) constituting 82.5 % of the study population.

Using the real leg length (RLL) as the determinant of prevalence of limb length inequality, 92 of our subjects had LLI thus given a prevalence rate of 89.3%. The LLI prevalence for female was 82.4% while that of the male was 96.2% thus male subjects had a higher LLI prevalence rate. The range of LLI in this study was 0.5- 2.5 cm with majority being under 2.0 cm. The male subjects had significantly higher limb length inequality (1.18±0.83 vs 0.75±0.60 cm).

The mean absolute leg length (ALL) for the right limb was 98.07 ±5.71 cm, with measurements occupying a range of 85.50 to 115.00 cm; respective values for the left limb was 98.25± cm and 86.50 to 116.50 cm. The mean male ALL was 100.81±5.89 cm (right) and 101.09±5.87 cm for the left side. The range was 90.00- 115.00 cm for the right limb and 90.00-116.50 cm for the left limb. The females had a mean ALL of 95.48±4.17 cm for the right limb and 95.58±4.24 cm for the left limb while the respective range was 85.50-105.00; and 86.30 - 104.00 cm. The difference between the right and left mean real leg length (RLL) was very negligible and the respective range was 80.50 - 108.00 and 79.50-110.50 cm. The female mean RLL was 89.55±4.61(right) and 89.31±4.53 cm (left) and the range for the right was 80.50 - 102.00 and left, 79.50 -100.00 cm. The mean RLL for the male was considerably higher- right 94.40 ± 5.69 cm and left 94.64±5.86 cm likewise the range (84.00-108 for the right limb and 83.00- 110.50 cm for the left limb). The mean femur length of both limbs was essentially the same (R: L; 42.79±3.07 :42.92±2.94 cm) and both had same range of 37.00-52.00 cm. The pattern of femur length for male was mean of 43.06 ±3.30 cm (right) and 43.37±3.05cm (left) and the range for both sides was 38.00-52.00 cm. The mean femur length for the female was 42.53 ±2.54 (right) and 42.50 ±2.80 cm (left) and respective range was 37.00-52.00 and 37.00-51.00 cm. The difference between the right and left mean tibia length was less than 1mm (37.30±2.94 vs 37.36±2.70 cm) and the range of the tibia length was 31.50-45.00 (right) and 32.00-47.00 cm left. The mean length of the tibia in the males on either side was 37.92±2.76 on the right and 38.09±2.97 cm on the left. While corresponding values for the females were 36.72±2.54 and 36.67 ±2.52 cm respectively. As for the range of the tibia length, the male values were 32.00-45.00 cm (right) and 32.00-47.00 cm (left) those of the female were 31.50-42.00 on the right and 32.00-42.00 cm on the left. In the male, the mean length of the fibula on the right was 39.15 ±2.99 cm and on the left was 39.22 ±3.22 cm with the respective range being 33.50- 47.50 and 33.00-47.00 cm. The mean length of the female fibula was 37.41 ±2.47 (right) and 37.36 ±2.44 cm (left) with respective range of 32.50 – 45.00 cm and 32.50-44.00 cm. The overall mean length of the right fibula was 38.25± 2.86 cm and for the left was 38.26±2.87 cm ; with respective range of 32.50 – 47.50 and 32.50 – 47.00 cm. The mean foot length was 25.12 ±1.60 cm (right) and 25.30±1.65 cm (left) while the range for the right was 21.00 – 29.50 cm and left 21.00 – 30.00 cm (right). The male had a mean length of 25.91 ±1.48 cm for the right foot and 26.25 ±1.38 cm for the left foot; the range for the right was 22.50 - 29.50 cm and 22.50 -30.00 cm fort the left. The mean length of the female foot was 24.38±1.35 (right) and 24.40±1.35 cm (left) and had a range of 21.00- 27.50 cm on both sides. The mean height of the calcaneum was very similar on both sides 5.24±0.64 likewise the range 3.50-7.00 cm. Both male and female calcaneal mean length was nearly the same 5.30±0.70 cm and 5.18±0.58 cm respectively. The thigh girth ranged between 41.50 and 78.80 cm for the right and from 43.00 to 77.80 cm on the left; the mean girth was 53.03 ±7.21 cm for the right thigh

and 52.79 ±7.87 cm for the left. The mean thigh girth for the male was 50.48 ±6.93 (right) and 49.80 ±7.79 cm (left) and the respective range was 41.50-78.80 and 39.80-77.80 cm. The female had wider thigh girth (55.48±6.66 –right, 55.28±6.82 cm – left) and the range for the right thigh was 43.70 – 72.30 cm and 43.00 – 73.00 cm for the left thigh. The mean leg girth was 29.77 ±2.82 (right) and 29.66 ±2.83 cm (left) while the range was 24.70-39.80 cm for the right leg and 24.80-39.30 cm for the left leg. The mean girth of the male leg was essentially the same for both sides and the female leg had a pattern similar to that of the male (Table 1). Analysis of the results along ethnicity line did not reveal any remarkable difference rather, each of the parameters exhibited very similar values for respective parameter (Table 2)
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Table 1: Lower limb somatometry values

Parameter	Mean (cm) (N= 103)		Range (cm)		Male Mean (cm) (N=50)		Male Range (cm) (N= 50)		Female Mean (cm) (N=53)		Female Range (cm) (N=53)	
	R	**L**	**R**	**L**	**R**	**L**	**R**	**L**	**R**	**L**	**R**	**L**
ALL	98.07	98.25	85.50	86.50	100.81	101.09	90.00	90.00	95.48	95.58	85.50	86.30
	±5.71	±5.78	115.00	116.50	±5.89[a]	±5.87[b]	115.00	116.50	±4.17[a]	±4.24[b]	105.00	104.00
RLL	91.90	91.87	80.50	79.50	94.40	94.62	84.00	83.00	89.55	89.31	80.50	79.50
	±5.69	±5.83	108.00	110.50	±5.69[c]	±5.86[d]	108.00	110.50	±4.61[c]	±4.53[d]	102.00	100.00
FL	42.79	42.92	37.00	37.00	43.06	43.37	38.00	38.50	42.53	42.50	37.00	37.00
	±3.07	±2.94	52.00	52.00	±3.30	±3.05	52.00	52.00	±2.85	±2.80	52.00	51.00
TL	37.30	37.36	31.50	32.00	37.92	38.09	32.00	32.00	36.72	36.67	31.50	32.00
	±2.94	±2.70	45.00	47.00	±2.76	±2.97	45.00	47.00	±2.54	±2.52	42.00	42.00
Fb L	38.25	38.26	32.50	32.50	39.15	39.22	33.50	33.00	37.41	37.36	32.50	32.50
	±2.86	±2.87	47.50	47.00	±2.99	±3.22	47.50	47.00	±2.47	±2.44	45.00	44.00
CH	5.24	5.22	4.00	3.50	5.30	5.34	4.00	3.50	5.18	5.11	4.00	4.00
	±0.64	±0.63	7.00	7.00	±0.70	±0.73	7.00	7.00	±0.58	±0.50	6.50	6.00
Ft L	25.12	25.30	21.00	21.00	25.91	26.25	22.50	22.50	24.38	24.40	21.00	21.00
	±1.60	±1.65	29.50	30.00	±1.48[f]	±1.38[g]	29.50	30.00	±1.35[f]	±1.35[g]	27.50	27.50
TG	53.03	52.79	41.50	43.00	50.48[h]	49.80[k]	41.50	39.80	55.48[h]	55.28[k]	43.70	43.00
	±7.21	±7.87	78.80	77.80	±6.93	±7.97	78.80	77.80	±6.66	±6.82	72.30	73.00
LG	29.77	29.66	24.70	24.80	29.43	29.33	25.50	25.50	30.09	29.97	24.70	24.80
	±2.82	±2.83	39.80	39.30	±2.74	±2.73	39.80	39.00	±2.95	±2.92	38.70	39.30
Mean Height					1.73 ± 0.09[n] (m)				1.63±0.07[n] (m)			
LLI (cm)					**1.18±0.83[p]**				**0.75±0.60[p]**			
Prevalence of LLI					**96.2%**				**82.4%**			
Overall Prevalence of LLI	**89.3%**											

ALL-Absolute leg length, RLL- Real leg length, FL- Femur length, TL- Tibia length, Fb L-Fibula length, Ft L-Foot length, CH- Calcaneal height, TG- Thigh girth , LG- Leg girth and LLI-Limb length inequality

For the range, the upper value is the minimum while the lower value is the maximum.

**[a, b, c, d, e, f, g, h, k & n] are paired parameters with significant differences (P value ≤ 0.05).

Table 2: Ethnic distribution of Lower limb somatometry values

Parameter	Mean (cm)		Range (cm)	
A	**Yoruba (58)**			
	R	L	R	L
ALL	98.31 ±6.15	98.47 ±6.34	88.00-115.00	88.00-116.50
RLL	92.16 ±6.22	92.25± 6.29	82.00-108.00	81.50-110.50
FL	43.03 ±3.42	43.09± 3.25	37.50 -52.00	37.00-52.00
TL	37.13 ±2.89	37.28 ±3.12	31.50- 45.00	32.00- 47.00
Fb L	38.39 ±3.19	38.33 ± 3.19	33.00- 47.50	33.00- 47.00
Ft L	25.14 ±1.72	25.33 ±1.74	21.00 - 29.50	21.00- 30.00
CH	5.22 ± 0.71	5.16 ± 0.66	4.00- 7.00	3.50- 6.50
TG	47.30 ± 8.08	47.70 ±8.26	41.50 - 78.80	39.80 - 77.80
LG	27.00 ± 3.14	26.00 ±3.07	25.50- 39.80	25.00 - 39.30
B	**Igbo (18)**			
ALL	99.28 ±6.13	99.33 ±5.86	87.00 -110.00	87.50 - 111.00
RLL	92.78 ±5.36	92.61 ±5.51	81.00 -102.00	80.50-103.00
FL	42.86 ±2.76	43.00 ±2.85	38.00- 48.70	38.00- 47.00
TL	38.00± 2.58	38.00 ± 2.64	32.50- 41.00	32.50- 41.50
Fb L	38.94 ±2.77	39.11 ± 2.64	32.50- 43.00	32.50- 43.00
Ft L	25.72± 1.37	26.06 ± 1.27	23.00 - 28.00	23.00- 28.00
CH	5.28 ± 0.75	5.28 ± 0.75	4.00 - 6.50	4.50-7.00
TG	53.93 ± 5.36	53.71 ± 5.15	47.20- 69.70	47.70- 68.30
LG	30.39 ± 2.20	30.56 ± 2.30	27.50 -34.50	27.30- 34.70
C	**Edo (9)**			
	R	L	R	L
ALL	98.56 ± 4.26	99.40 ± 4.52	93.00- 105.50	93.50-106.00
RLL	93.22 ± 5.06	93.44 ± 5.18	88.50- 100.00	86.00 -100.50
FL	42.39 ± 1.83	43.0 ± 2.00	39.00- 45.00	40.00- 46.00
TL	38.67 ± 2.11	38.17 ± 2.11	36.00- 42.00	35.50- 40.50
Fb L	38.17 ± 2.11	38.50 ± 1.90	36.00- 41.00	36.00- 41.00
Ft L	25.56 ± 1.61	25.44 ± 1.42	23.50- 28.00	23.50- 28.00
CH	5.22 ± 0.51	5.33 ± 0.50	4.50 - 6.00	4.50 - 6.00
TG	55.67 ± 7.03	56.38 ± 6.84	47.80 -69.00	47.50 -69.50
LG	30.63 ± 2.83	30.56 ± 2.71	27.80- 36.30	27.80- 36.30

ALL-Absolute leg length, RLL- Real leg length, FL- Femur length, TL- Tibia length, Fb L-Fibula length, Ft L-Foot length, CH- Calcaneal height, TG- Thigh girth and LG- Leg girth. For the range, the upper value is the minimum while the lower value is the maximum.

4.DISCUSSION

The anterior superior iliac spine is at the same transverse plane with the head of the femur, thus the distance from it to the inferior limit of the calcaneum is actually the entire length of the lower limb. This is equivalent to the sum of the real lower limb length and calcaneal length. The umbilicus is in the same transverse plane with the third and fourth intervertebral junction, thus using it as a reference point for lower limb length incorporates the terminal quarter of the trunk into the limb. However due to ease of identification, it also used for lower limb length measurement; thus such value is referred to as apparent leg length. It should be noted that the lower limb as an entity does not function in isolation but rather in synergy with the pelvis thus the apparent leg length is the functional length while the real leg length constitutes the anatomical length.

In this study, both the whole lengths (i.e apparent leg length and real leg length) and the segmental lengths of the femur, tibial, fibula, foot and calcaneal height showed side inequalities. These side inequalities were very small and in fact less than one centimetre. Both girths, ie thigh and leg also exhibited side inequalities. These side inequalities were of no specific pattern i.e for some, the right was higher while for others it was the left. Those in the former category include the Real limb length, Calcaneal length and Leg girth while the Apparent leg length, Femur length, Tibial length, fibula length, foot length and Thigh girth were of the latter category. It was also observed that none of these side inequalities was of statistical significance. These negligible differences between the right and left lower limb length could explain why limb length inequality is not obvious in the normal walking and running gait.

This study has been able to establish that inequalities of lower limb length exist between the corresponding sides of male and female leg. Expressed numerically, the male lower limb is averagely five centimetre (5cm) longer than its corresponding female counterpart. Though all the segments of the lower limb account for these differences, the leg segment is largely responsible for these inequalities. Segmental lengths in which inequalities exist include the apparent leg length, real leg length and fibula length. In all of these lengths, the male values were significantly longer than the corresponding female values. The right male foot was significantly longer than its female counterpart and similar observation was made for the left. This gender disparity in height and segmental lengths may the genetic in origin. The principal male sex hormone is the testosterone and this is largely produced by the gonads (testes) while the female sex hormones are the estrogen and progesterone overtly synthesized by the ovaries. Testosterone is known to stimulate radial and longitudinal bone growth. As would have been expected, the female had significantly wider thigh girth than the male This expectation is borne out of the fact that the female has increased fat deposit in the thigh. Estrogen has direct effects within adipose tissue and has been implicated in regional adiposity [15]. Women have increased tendency to accumulate fat especially in the subcutaneous layer and gynoid region than men [16]. A gynoid pattern of fat distribution is a low body segment fat particularly in the hip and thigh. The female leg girth was not significantly wider than that of the male thus it may be reasonably concluded that females have significantly greater tendency of increased adipose tissue deposition in the thigh and not in the leg than males.

Comparison of the limb parameters amongst the three ethnic groups of Yoruba, Igbo and Edo did not reveal any significance difference either intra ethnic or inter ethnic. All these ethnic groups are Negroid this may explain the similarities in the lower limb parameters and the existence of none significance.

Significant lower limb inequality may result in altered pelvic and lower limb biomechanics with consequent pelvic obliquity in the coronal plane. The distorted pelves will result in functional scoliosis, deformed posture, asymmetric gait, lower back pain, gonarthrosis or coxa arthrosis [17]

The gold standard for the evaluation of lower limb inequality is radio imaging which include plain radiographs, scanograms, computerized tomography and magnetic resonance imaging. Apart for exposure to ionizing radiation, cost and logistics render these techniques impracticable for being used for population study to which the present study belongs. Both the direct measurement approach and the radio-imaging techniques cannot be used for dynamic lower limb discrepancy. However, the described technique for dynamic lower limb discrepancy during the gait cycle variously known as Modified Helen Hayes, Kadaba, Newington and Gage [18] is very limited in application. This biomechanical model allows analysis of discrepancy during the stance and swing phases of gait, it can only be deployed in a laboratory setting, hence its relevance is much more in clinical evaluation of patients with length limb discrepancy. In a review of mixed multitude of eight studies on limb length inequality spanning between 1983 and 1997, involving 573 human subjects, the mean LLI was 0.51 ±0.41 cm with a range of 0-2cm. In those studies LLI was assessed radiologically and the subjects included marathon runners and patients with musculoskeletal symptomatology [13]. Although our study involved persons with grossly normal limbs, our LLI range of 0.5-2.5 cm (majority being less than 2.0cm) was to what was obtained in that review. Also in that review, the left leg was found to be longer than the right in our study the difference in length between both lower limbs was negligible. This non-concordance in limb length might be due to difference in methodology as our study used direct measurement while theirs utilized radiology. Our study revealed that in normal population, the male left leg is significantly longer than its female counter part and similar observation holds for the right lower limb. This gender disparity in limb length may be attributable to testosterone which is the male sex hormone. There are other studies that had reported the left limb being anatomically longer than the right [19-21]. What makes the left leg to be longer than the right is not known, if this is attributed to the sigmoid (pelvic) colon then there should have been tilting of the pelvis to the left but this is not so; thus the cause of a longer left limb is unknown. Some radiographic studies that analysed their results along gender line did not report any remarkable disparity between male and female lower limbs [5,9,12,22]

A lower limb inequality prevalence rate of 89% is very close to the 90% prevalence obtained by related studies [23,24]. Thus anatomic limb inequality is very common but not obvious because all the subjects of this study had normal gait had no symptom related to limb discrepancy. Lower limb inequality becomes an issue of clinical significance when there is superadded pelvic or limb pathology. In discussing LLI prevalence one as to take into consideration the demographics of the study population as this is bound to affect the rate. The available rates in the literature for normal population differ greatly from those of patients with varied symptomatology such as low back pain, post limb skeletal injury and skeletal deformities [25]. Also the method of study whether it is clinical (direct and non-direct) or radiological and the proficient level of the examiner will affect the rate thus all these variables have to be taken into consideration in comparing prevalence rates.

Computerized tomography (CT) scan is considered the gold standard for lower limb length measurement from the viewpoints of high accuracy and very low radiation dose which is 80% less than plain radiography [26,27]. However ethical consideration does not permit its use in studies that involve population with grossly normal lower limbs such as ours. Cost of CT scan is another major consideration in its deployment for anthropometric studies. The reliability and accuracy of tape measure method in determination of lower limb length has been evaluated by several comparative studies with plain radiograph and CT scan [28-30]. Such studies reported very high correlation coefficients even above (0.991). From the fore going and couple with the fact there was no significance difference in any of the measured parameters amongst the three major ethnic groups sampled in this study, the results of this study could thus serve as base line lower limb length data for the Nigerian population.

Conclusion

Lower limb inequality exists amongst young adults Nigerians with grossly normal lower extremities that are asymptomatic for musculoskeletal pathologies. The LLI is of high prevalence but very low in magnitude this may account for its being innocuous

Consent

Prior to the commencement of the study, informed consent was sought and obtained from the participants and none was either coerced or gratified. The probable risks and benefit of the study were adequately and clearly communicated to the participants.

Ethical Approval

Formal approval for the study was sought for and granted by the University of Ibadan / University College Hospital Research Ethics Committee. The conduct of this human study was in strict compliance to the guidelines and regulations of the Ethical body.

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