Correlation between Body Mass Index and Tibiofemoral Angle in Adult Nigerian Patients with Primary Knee Osteoarthritis. A Pilot Study

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ABSTRACT

Background: Chronic knee osteoarthritis, which represents the clinical manifestation of cartilage disintegration under various factors, including abnormal joint loading, is a common pathology globally. Factors such as obesity and malalignment are thought to play a role in its aetiopathogenesis and progression. There have been studies evaluating the relationship between the severity of symptoms in these patients, but the relationship between the tibiofemoral angle (TFA) and body mass index (BMI) in patients with primary knee osteoarthritis has not been extensively studied. **Methodology:** we prospectively evaluated 51 patients aged 50 years or older with clinical and radiological features of chronic osteoarthritis of the knee and who had not had any form of intervention before assessment. Clinical and radiological tibiofemoral angle (cTFA and rTFA) measurements, and BMI calculations from weight and height measurements, were obtained. We then determined the presence of a correlation between these variables. **Results:** The average ages for male and female subjects were 66.7 years and 67.5 years, respectively. Both males and females were obese, with similar BMIs of 32.8 and 32.6, respectively. Males had a varus angulation of 5 degrees on cTFA and rTFA measurements, while females had 2.5 degrees and 3.1 degrees of valgus angulation for the cTFA and rTFA, respectively. We found no correlation between cTFA or rTFA and BMI in either sex. **Conclusion:** We determined that the BMI in obese patients with primary knee osteoarthritis did not influence the magnitude of the clinical or radiological tibiofemoral angles.

Keywords: Knee Osteoarthritis, Body Mass Index, Tibiofemoral angle

INTRODUCTION

Chronic osteoarthritis is the clinical manifestation of abnormal joint loading with consequent deterioration and disintegration of articular cartilage. It represents "a heterogeneous group of conditions that lead to joint symptoms and signs associated with defective integrity of articular cartilage, in addition to related changes in the underlying bones at the joint margins[1]. It is a significant contributor to the global disability burden and is an important

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cause of disability worldwide.[3] Osteoarthritis accounted for more than an estimated US$ 10.5 billion in hospital costs in 2006 in the United States alone, with admission figures doubling from 1993 to 2006.4

It affects more than 37% of adults above 60 years of age in the United States of America 5 and 16 – 19% of Nigerians above the age of 30 – 40 years, with a significant rise in prevalence rates as age increases.[6,7] The knee is the most commonly affected joint globally.[8,9,10] Increasing age, genetic predisposition, racial predilection, and gender have been identified as possible aetiological factors for the development of primary osteoarthritis. In addition, axial loading and obesity have been identified as risk factors and consequently play a significant role in the pathogenesis and clinical manifestation of the pathology.[11] The observation that as the condition progressively worsens, complications like angular deformities ('bow-leg' and 'knock-knee') become manifest and more common further strengthens this opinion. While malalignment and obesity are predisposing risk factors for the onset and progression of knee OA, a progression of the pathology is also known to result in a reduction of cartilage volume, instability, and further joint/limb malalignment.[12,13,14] Malalignment, in particular, has been shown to play a big part in the progression of knee osteoarthritis.[15] While most of these studies have focused on the relationship between obesity and the severity of symptoms, not many have looked at the magnitude of deformity and its relationship to obesity in these patients.

The normal range for knee angles in several adult populations, including Nigerians, has been described by several authors.[16,17,18] In a study involving normal Nigerian children, an increase in body mass index (BMI) was not related to an increase in the magnitude of the tibiofemoral angle (TFA).[19] However, there is a lack of data on the relationship between BMI and the TFA in adult Nigerians, particularly those with knee osteoarthritis.

This study aims to determine the relationship between BMI and TFA in adult Nigerian patients presenting with features of Primary osteoarthritis of the knee.

METHODOLOGY

This prospective cross-sectional, hospital-based study was conducted following clearance from our institution's ethics review committee. Consecutive patients aged 50 years or older presenting at the orthopaedic outpatient department of our facility with clinical and radiological evidence of chronic osteoarthritis of the knees were eligible for inclusion in this study. As we sought to assess only those with primary osteoarthritis, we excluded all those found to have obvious identifiable causes from the study. Also excluded were those who had undergone surgery as a treatment option for osteoarthritis (arthroplasty or re-alignment osteotomy). We also sought uniformity in the study population, so we only included those with bilateral knee affectation.

Data collected included sociodemographic data, symptoms, height, weight, and BMI. We used a simple bathroom scale to obtain patients' weight in kilograms. We took weight measurements after subjects stripped down to their undergarments. Height was measured in centimetres using a wall-mounted stadiometer. Subjects were required to stand unshod with their backs to the wall and occiput, buttock, and heel touching the wall for height measurement. We calculated the body mass index (BMI) using the formula developed by Adolphe Quetelet, body weight in kilograms divided by height in metres squared.

weignt in Kilograms / height in metres^2

The Clinical and radiological tibiofemoral angles (cTFA and rTFA) were measured using a standard goniometer. We employed the same methods that previous authors have used to obtain these measurements.[1921] For the clinical TFA, subjects stood unsupported with their lower limbs in neutral rotation and patella facing forward. The femoral axis was determined by palpation as an imaginary line running

from the anterior superior iliac spine (ASIS) to the centre of the patella. The tibial axis was similarly determined and defined as an imaginary line running from the centre of the patella to a point midway between the medial and lateral malleoli. The clinical tibiofemoral angle was the acute angle at the point of intersection of these two imaginary lines. Positive values represented varus alignment, while negative values represented valgus alignment.

We measured the radiological TFA from full-length standing anteroposterior x-rays of the lower limbs. Patients were positioned standing, with the patella facing forward, as described by Paley. [22,23] We determined the radiological mechanical axes of the femur and tibia by a line connecting the centre of the femoral head and the centre of the knee and another connecting the centre of the knee and centre of the ankle, respectively. The radiological TFA was the acute angle subtended at the point of intersection of these two lines. Positive and negative values represented varus and valgus alignments, respectively. To minimize inter-observer differences, the second author, OP, carried out all measurements in the clinic. We took measurements from both limbs, and the average was determined and recorded for each subject.

Data generated was expressed in tabular or graphical form as deemed appropriate. Measures of central tendency were expressed as mean with variance represented by the standard error of the mean, SEM. Spearman's rank correlation test was performed using GraphPad Prism version 9.0.0 for Windows, GraphPad Software, San Diego, California USA, www.graphpad.com.

RESULTS

We evaluated 51 patients (7 male and 44 female). The mean ages for males and females were 66.7 and 67.5 years, respectively. Males were also heavier than females in this study, with an average weight of 89kg compared to 84.5kg for females. We found BMI to be similar for both groups, with males having an average BMI of 32.8 and females at 32.6. The cTFA and rTFA in males were the same, with a varus angle of 5 degrees. Females, on the other hand, had 2.5 degrees of valgus for the cTFA and 3.1 degrees of valgus for the rTFA. A summary of our findings is represented in table I.

We found good correlation between clinical and radiologic TFA in males and females, (Spearman r Values of 1 and 0.91 respectively for males and females). However, we found no correlation between cTFA and BMI or rTFA and BMI in both males and females in this study (Fig. 1)

Table I: Means according to sex for Age, weight, BMI, Clinical and Radiological TFA and Femoral NSA

Sex	Age	Weight	BMI	Clinical TFA	Radiological TFA
Male	66.7±2.5	89±3.8	32.8±1.6	5±4.1	5±4.1
Female	67.5±1.3	84.5±1.9	32.6±0.7	-2.5±1.8	-3.1±2.0

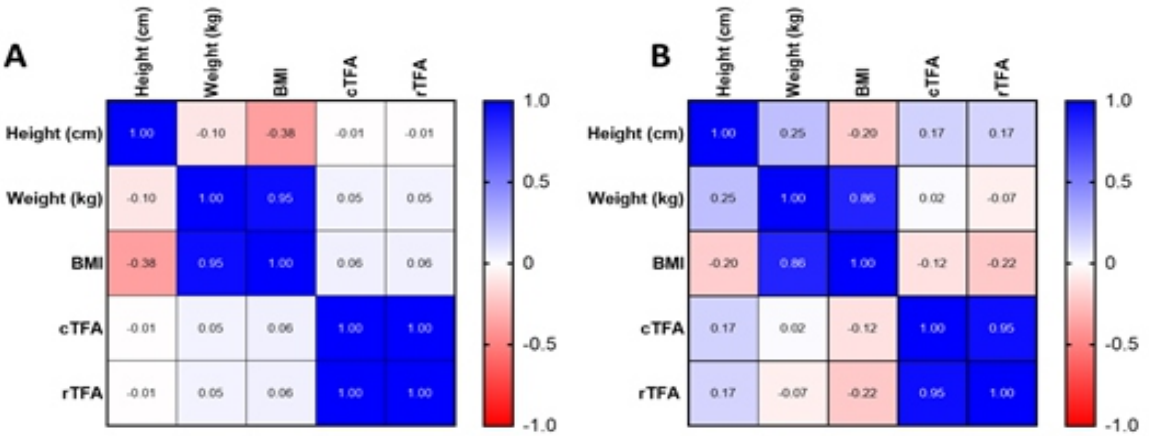

Fig. 1. Correlation matrix based on Spearman's rank correlation showing r value comparisons between variables for male and female patients (A and B respectively). BMI – Body Mass Index, cTFA – clinical tibiofemoral angle, rTFA – radiological tibiofemoral angle, cm – centimeters, kg – kilograms.

DISCUSSION

Our study showed that the magnitude of the clinical or radiological TFA in adults with chronic knee osteoarthritis is not related to the BMI in these patients. Our findings also reaffirm the fact that the clinical TFA has good correlation with the radiological TFA.

Chronic knee osteoarthritis is commoner in females.24 Ebong, in his review of 116 knees in 81 patients in southwestern Nigeria, found a 66.7% prevalence in women with a M:F ratio of 1:2.24 A female predominance was confirmed in our study, consistent with local and global trends; however, we found a higher M:F ratio of 1:6 in contrast to the smaller values of 1:1.5-2 found in other reported studies.[6,7,25,26,27,28] The basis for this disparity is not immediately clear. One possible reason for this is that our study population was limited to subjects 50 years and older, and indeed, the mean age for presentation in both sexes was 66.7 and 67.5 years, respectively, for males and females. We do not know if expanding the inclusion criteria to recruit younger patients would have affected the sex ratio. Studies have demonstrated a significant increase in the incidence of OA with age, and the sex ratio may be just as different in this older population of patients as the prevalence is. Some studies have also reported a greater health-seeking behaviour amongst females.[29,30] It is also possible that this factor may have played a role in the observed difference.

The normal range and magnitude of the tibiofemoral angle have been studied in various populations.[16,17,18] Vankka and Salenius found a good correlation between clinical and radiological tibiofemoral angles.20 This relationship was also demonstrated in this study, thus supporting the use of the clinical TFA in place of the radiological TFA when necessary. Genu deformities have been associated with chronic OA of the knees. In a study by Ebong, genu deformities were present in 30.8% of all subjects, with valgus deformity being the more common presentation.[24] Adebusoye *et al*., in contrast, found that varus deformity of the knee was a significant factor associated with knee OA.[26] Whether this is a cause, or a consequence remains to be determined, but it is plausible to think of the relationship as both cause and effect, with one leading on to the other and vice versa. In our study, we found an average cTFA of 2.5 degrees of valgus and rTFA of 3.1 degrees of valgus in females, which is essentially within the normal range for TFA in adults and 5 degrees of varus (cTFA and rTFA) in males which is abnormal for this group of patients.

While it has been noted that not all patients with knee OA are obese and, conversely, not all obese patients develop knee OA, experimental studies have been carried out to determine the role of abnormal joint loading on the mechanical properties, composition, and structure of articular cartilage.[31,32] In a study on Nigerians with knee OA, obesity was associated with 25.9% of female subjects, while only 3.7% of male subjects were found to be obese.24 There is mounting evidence of a positive relationship between obesity and the prevalence of knee osteoarthritis.[26,27] In a population-based review of 27,960 subjects, Lohmander *et al*. found a significant relationship between BMI and severe OA of the knee.28 Akinpelu et al. noted that Obese subjects had significantly more severe symptoms of knee OA compared to overweight and normal for weight individuals.[7] We found in this study that on average, our patients were obese, with mean BMI measurements of 32.8 and 32.6 for males and females, respectively. We found no correlation between BMI and the clinical or radiological TFA in these patients. In particular, we found that the clinical and radiological TFA in females were within normal limits.

One of the limitations of this study is that we, did not relate BMI with the severity of clinical symptoms like pain or radiological grading of osteoarthritis, as this was not the intention of this study. Within the last ten years, an increasing understanding and application of molecular biology techniques have led to a deeper

understanding of the relationship between fatty tissue and the aetiology of osteoarthritis. It is now thought that rather than a purely mechanical effect on the joints, there is an inflammatory environment caused in part by the secretion of active agents like adipocytokines such as leptin and adiponectin into plasma and synovial fluid, which are then thought to play a role in the homeostasis of articular cartilage.[33,34]

CONCLUSION

In this study, we determined that there is no relationship between the BMI of adult patients with primary osteoarthritis of the knees and the clinical and radiological TFA.

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