Relationship between Body Mass Index And Knee Alignment Using Non-Radiographic / Umbilical Method

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Abstracts: Aim: The aim of the research was to investigate the relationship between body mass index and knee alignment angle using non-radiographic methods, and to propose a regression equation to define the relationship.**Method:** A total of 300 students (200 males, 100 females) of Nnamdi Azikiwe University, Nnewi campus participated in the study. Knee alignment was measured using body landmarks (umbilicus, right knee and right second toe) with a goniometer and calliper; the body mass index was also determined.**Result:** The male subjects had a mean body mass index of 24.2 kg/m^2 and knee alignment angle of 176.5^o. The female participants had a mean body mass index of 22.7 kg/m^2 and knee alignment angle of 180.9^o. Body mass index had no significant relationship with knee alignment in both males and females respectively ($r = 0.009$, $p > 0.05$; $r = 0.065$, $p > 0.05$). **Conclusion:** The study showed no significant positive relationship between body mass index and knee alignment, and body mass index is therefore not a good determinant for the control of knee alignment-based knee osteoarthritis. [Ukoha U NJIRM 2014; 5(3):33-36]

Key Words: Body mass index, knee alignment, knee osteoarthritis, correlation.

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Introduction: Knee osteoarthritis is a leading cause of disability in older persons[1] and is a common disease affecting elderly individuals[2] so there is an increasing interest in understanding the incidence, progression and management of osteoarthritis[3]. Many factors are known to increase the risk of knee osteoarthritis of which body mass index and knee alignment are the two most important[1-3]. Studies suggest that the risk of knee osteoarthritis increases from exposure to a high body mass index through adulthood[4].

Knee alignment angle, a measure of mechanical axis, has been reported to correlate with severity and progression of knee osteoarthritis. Mechanical joint stress imposed by high body mass index is associated with increased risk of knee and hip osteoarthritis[5]. Evaluation of knee alignment is useful in the diagnosis of arthritic condition affecting the knee joint, serving also as a guide to conservative management and surgical planning. They are also fundamental to various aspect of musculoskeletal research.

The gold standard radiographic method has been used as an accurate measure for knee alignment angle which involves long leg radiograph although this method has been met with few limitations such as cost, lack of availability to researchers and exposure to radiation[6]. There is therefore a need to employ a non-radiographic assessment for the knee alignment using umbilical methods which involves the use of body landmarks (umbilicus, knee and second toe). The non-radiographic measure of frontal plane has been reported to correlate with the gold standard radiography[6-8].

The purpose of this study is to investigate the relationship between knee alignment and body mass index and also to propose a regression equation to represent this relationship.

Materials And Method: The Study Was Carried out in the gymnasium unit of the Department of Medical Rehabilitation, College of Health Sciences, Nnamdi Azikiwe University, Nnewi campus. Ethical approval was sought and obtained from the Ethical Committee of the Faculty of Basic Medical Sciences.

Sample Size: Sample size was determined, using the formulae

$n=N/(1+N(e)^2)$ where 'n' = required sample size, 'N' = population of study, 1 = statistical constant, 'e' = 0.05 (error of margin at 5%).

With a student population of about 1000, the calculated sample size was 307.

A total of 300 students participated in the study (200 males, 100 females). The participants had no deformity of the knee joint or lower limbs and no history of previous neuromuscular skeletal pathology of knee and lower limbs.

Knee Alignment: The knee alignment was obtained using a goniometer with the use of body landmarks (umbilical method). From the anatomical and functional perspective, the orientation of the femur and tibia at the knee is best described in terms of the bones' mechanical axis[9] which is used in calculating knee alignment in long-leg radiographs; the umbilical method on the other hand uses the anatomical axes rather than mechanical axes. Prior to data collection informed consent was obtained from the participants to proceed with data collection; subjects were instructed to take three marching steps in place and stand in the anatomical position with the knees and ankle adducted. The proximal, middle and distal landmarks were then identified. The umbilicus was chosen as the proximal landmark, the centre of the right knee joint line as the middle landmark and the right second toe (a point equidistant from the medial and lateral malleoli) as the distal landmark (see **Error! Reference source not found.**), both the middle and distal were located with a calliper. The height and weight of the participants were also taken to derive values for the body mass index.

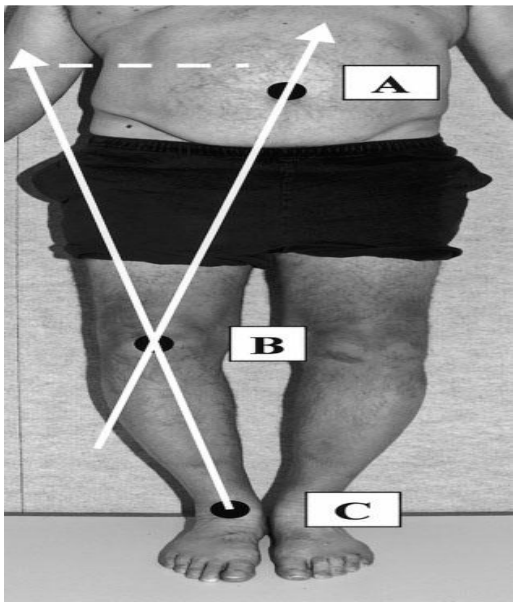

Figure 1: Diagram Showing Axis For Knee Alignment Angle Measurement (Picture Reproduced From Gibson *Et Al*,[0])

All data were analysed using the SPSS for Windows, Version 16.0 (SPSS, Chicago, IL). Descriptive statistics were calculated for measures of alignment, age, height, and weight and body mass index. Independent sample t-test for gender differences in all the parameters was done. The correlation between body mass index and knee alignment were determined using Pearson correlation (r). Then finally a regression equation was proposed to represent the relationship between body mass index and knee alignment. The statistical significance for all analysis was accepted at $p<0.05$.

Results:

Table 1: Body Mass Index, Alignment Anddemographic Characteristic Ofthe Study Population.

Charateristics	Males (N=200)	Female (N=100)	P-value
Age (Yrs.)	21.35±1.85	22.1±2.43	0.001
Weight(kg)	73.6±8.3	65. ±9.4	0.000
Height (m)	1.75±0.07	1.7±0.08	0.000
BMI (kg/m^2)	24.2±2.9	22.7±2.7	0.044
Knee Alignment	176.5±3.0	180.9±3.9	0.000

Mean and standard deviation of the age, height, weight, knee alignment and body mass index of the subjects are presented. Independent sample t-test indicated significant gender differences in all the parameters. The female subjects had significantly greater age ($P<0.05$) and knee alignment angle

(P<0.001), whereas the males had significantly greater weight (p<0.001), body mass index (p<0.05) and weight (p<0.001).

Table 2: Correlation Coefficient Between Body Mass Index And Knee Alignment In Males And Females.

Male		Female	
Coefficient(R)	P-Value	Coefficient(R)	P-Value
0.009	0.897	0.065	0.520

Table 2presents Pearson's correlation test which indicated insignificant non-correlation between body mass index and knee alignment in both males and females (p<0.05).

Table 3: Regression Equation For Estimating Knee Alignment Angle From Body Mass Index

	Regression Equation	± Se
Males	I76.2+0.01BMI	3.0
Females	178.8+0.09BMI	3.9

In Table 3 knee alignment angle was estimated from individual body mass index measurements using the linear regression equation; alignment = a + bx, where 'a' is theregression coefficient of the dependent variable, i.e. alignment, and 'b' is the regression coefficient of the independent variable, i.e. any body mass index, 'x' is any body mass index measurement.

Discussion: There is a need to measure frontal plane alignment as this is the most important factor associated with knee osteoarthritis after body mass index[0]. Also frontal plane alignment is one local intrinsic factor that accounts for variation in the force directed at the knee[7]. Total load and distribution of forces are affected by the orientation of the joint in the frontal plane[0].

Body mass index is known as the chief cause of knee osteoarthritis, as it increases the risk for the disease by four times[1], while the presence of alignment modifies this association[3]. The gold standard radiographic method is expensive, requires specialized equipment and expertise is unavailable to many clinicians and researchers. This study has therefore provided an accurate tool to effectively help researchers to determine the knee alignment using non-radiographic means.

An important limitation is the absence of full-limb radiographs, therefore preventing accurate measurement of mechanical alignment. Yet efforts were made to approximate the mechanical alignment by using the umbilical approach; this method has also been reported by Gibson *et al*[7] and Kraus *et al*[6], as the offset for anatomic compared to mechanic alignment. Although not optimal, the anatomical axis was shown to be correlated very well with mechanical axis measured using HKA axis (r= 0.88) [3].

Pearson's correlation showed an insignificant zero relationship between body mass index and knee alignment in both males (p>0.05) and females (p>0.05). This implies that body mass index is not a good indicator for the control of knee alignment-based knee osteoarthritis. This contradicts reports from Yusuf et al[3] who reported a significant relationship between body mass index and progression of knee osteoarthritis, but supports that of Niu et al[11] who reported no overall relationship between body mass index and knee alignment. A suggestion for the difference in results between that of Yusuf et al and this study was that 80% of the population used for their study were overweight (BMI > 25kg/m^2), leading to less contrast between overweight or obese patients with normal weight patients.

Conclusion: This study is beneficial as good knowledge of the factors that influence knee osteoarthritis and how it can be controlled helps to reduce the risk of the disease which is very common in the elderly. Body mass index and knee alignment are known key factors that increase the risk of knee osteoarthritis although the results showed that a high body mass index does not result in the development of knee alignment (varus/valgus alignment) and therefore the relationship between body mass index and knee alignment is insignificant. In conclusion, body mass index is therefore not a good determinant for the control of knee alignment based knee osteoarthritis.

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