



Correlation between gait speed and severity of knee osteoarthritis in a Nigerian population

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Abstract

Context: The prevalence of knee osteoarthritis (OA) is rising in Nigeria. Since X-ray imaging is often unavailable in rural areas, clinicians may rely on functional assessments like gait speed to evaluate disease severity.

Objective: To determine the association between Kellgren and Lawrence (K & L) grades 3 and 4 severity of knee Osteoarthritis and gait speed amongst patients seen at University of Benin Teaching Hospital.

Materials and Methods: This was a 12 month hospital based descriptive cross sectional study carried out on 56 adult patients with K & L 3 and 4 Knee OA in the University of Benin Teaching Hospital (UBTH). Participants were requested to walk a distance of 5 metres as fast as possible and safely (without the use of any walking aid) without running, after 15 minutes of rest. Timing was recorded with a stopwatch. This was repeated once and gait speed was measured using metre per seconds as an average of the two performances. Data was analyzed using SPSS version 22.

Results: K&L grade 3 knee OA was present in 60.7 % (n= 34) of participants, while 39.3% (n = 22) presented with K&L grade 4 knee OA. A statistically significant inverse association was observed between gait speed and knee OA severity ($p=0.001$). Mean gait speed was $1.09\pm0.18\text{m/s}$ for grade 3 subjects with most ranging between 1.0 and 1.5m/s. Conversely, mean gait speed for grade 4 subjects was $0.75\pm0.19\text{m/s}$, with the majority falling below 1.0m/s.

Conclusions: Gait speed is inversely associated with the K & L grades of Knee OA severity in the Nigerian population. Thus, measuring gait speed provides a simple tool to grade advanced disease severity and facilitate early specialist referrals in resource –limited settings.

Key words: Gait speed, knee osteoarthritis.

Introduction

Osteoarthritis (OA) is a degenerative musculoskeletal disorder causing significant disability.¹ It is a chronic disorder of synovial joints with progressive softening and disintegration of articular cartilage and associated new growth of cartilage and bones at the margin (Osteophytes), cyst formation, subchondral sclerosis, mild synovitis and capsule fibrosis.² It is an important disorder in orthopaedics because it can lead to significant restrictions in the walking ability of those with the disease.² With the increasing population of the elderly, the number of patients with OA is expected to continue to increase.^{3,4} Osteoarthritis is of two types: Primary and Secondary osteoarthritis. Primary Osteoarthritis occurs in a joint de novo and does not involve an inciting factor. It is more common than the secondary type. While Secondary Osteoarthritis follows a demonstrable abnormality or an underlying primary disease of the

joint which leads to degeneration of the joint months to years later. Majority of patients with knee OA present with knee pain which negatively affects their quality of life. The pain can be severe enough as to affect their activities of daily living.^{5,6}

There are several classification schemes for determining the severity of knee OA such as the

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Kellgren and Lawrence (K & L) classification, Ahlback and the outerbridge classification systems. However the K & L is the most widely used⁷. Kellgren and Lawrence (K & L) classifies knee OA into 5 grades of increasing severity based on radiographic structural changes that is seen on a knee anterior posterior radiographs.^{2,7} Thus the radiograph is a major investigative tool in assessing the severity of OA in patients. However, in some rural areas especially in developing countries, X ray machines are not readily available, hence the need to rely on clinical measurements such as gait speed which may become very useful if found to correlate with the severity of OA.⁸

Human gait can be defined as a series of alternating movements of the lower extremities in a rhythmic motion that results in forward progression of the body with minimal energy expenditure. Measuring gait function has become an essential tool in the assessment of mobility in the aging population for both clinicians and researchers. Several studies have shown that gait speed and lower limb stance phase correlate statistically with ambulatory function when compared to other parameters of gait.⁹ Gait speed evaluation offers the advantage of quick and easy measurement that can be performed with readily available and cheap equipments. Also, the clinical evaluation of gait speed in patients with knee OA if found to correlate with the severity, may become useful in determining who should be considered for further evaluation.

Despite the high prevalence of knee OA and its burden on patients and the health care systems, the diagnosis of knee OA is not straight forward. Knee OA is confirmed on clinical and/or radiological features.⁸ The definition of knee OA based on radiographic structural features such as the Kellgren and Lawrence criteria represent late stages of the disease because structural features develop slowly over time.⁹ In recent times, there has been a tendency to diagnosis and non-operative management of knee OA without unnecessary imaging due to the fact that imaging is not often recommended in patients who have typical knee OA presentation.^{10,11,12} Structural changes in knee OA have only modest agreement with symptoms; although the use of standing radiographs of the knees is retained for assessment of the severity of the condition.¹³ Knee OA severity is determined by clinical assessment and radiological investigations.¹³ The decision on type of treatment to

be given should be based on radiological assessment. However the decision on type of treatment to be given is often based on clinical assessment with application of patients reported outcome measurements such as the Oxford knee scores, Knee Injury and Osteoarthritis Outcome Score (KOOS) etc. Majority of the patients presenting to primary health care centres are often diagnosed of knee OA based on clinical criteria.^{8,10,14}

Though, these patients reported outcome measurements have gait as their components, the decision to classify or operate is taken into consideration with other components of the outcome measurements. Many a time patients in our environment are in difficulty on how to fill the patients reported outcome measurements forms and find it cumbersome. Therefore finding an easy way of relating radiological findings to clinical findings such as gait speed may provide a solution.

A review of the literature indicates that there are few studies on the relationship between gait speed and knee OA. The purpose of this study is to correlate Kellgren and Lawrence grade 3 and 4 knee OA with the gait speed (measured in metres per seconds) in patients presenting to the University of Benin Teaching Hospital. The finding of a relationship between gait speed and radiographic severity of knee OA will provide an objective tool for assessing the severity of knee OA clinically in patients diagnosed with the various clinical diagnostic criteria, thus allowing for further investigations, instituting appropriate treatments and help in facilitating early referrals of advanced knee OA to appropriate centres of care.

In a study done in Pittsburg, USA, among 190 participants, the gait speed for those with advanced knee OA based on Kellgren and Lawrence classification grade 3 and 4 was found to be 0.8m/s⁶. This was low as compared with the normal gait speed in adults, thus supporting a relationship between gait speed and knee osteoarthritis. However the study only compared Kellgren and Lawrence grade 3 and 4 with knee OA. Kellgren 1 and 2 was not included in the study and 3 and 4 was not separated to compare with the gait speed. Also of advantage is that the study excluded non ambulatory patient who would have negatively affected the mean gait speed.⁶

In another study done in North Carolina, USA among one thousand eight hundred and fifty eight

non-institutionalized residents aged 45 years and older comparing gait speed with knee and hip osteoarthritis. It was found that the gait speed was inversely related to the severity of knee OA, but no relationship was found with hip OA. This further suggests a relationship between knee OA and gait speed. The average gait speed for participants with knee OA was 0.7m/s as compared to normal of 1.2m/s. This was for individuals with Kellgren and Lawrence grade 3 and above. However the study did not grade the gait speed with the severity of the knee OA using the Kellgren and Lawrence classification. Also the population was largely overweight which may have accounted for the outcome of the relationship.¹⁵

Furthermore in a study done in Delaware, USA among 56 respondents to determine the differences in gait parameters between healthy subjects and persons with moderate and severe knee osteoarthritis, It was found that there were significant differences in the gait speed between the severe OA group which was 1.03 ± 0.26 m/s and the control group which was 1.22 ± 0.14 m/s. This shows a reduction in the gait speed in patients with severe knee OA, thus corroborating an inverse relationship between the severity of knee OA and the gait speed. Although the respondents with moderate OA had a slower gait speed (1.13 ± 0.12 m/s) than the controls, this was not statistically significant. Also there were significant differences in the mean fast gait speed; 1.75 ± 0.23 m/s, 1.50 ± 0.21 m/s and 1.37 ± 0.28 m/s for the control, moderate and severe OA group respectively. This shows an inverse relationship, as the severity of the knee OA increases the gait speed becomes slower and vice versa. This corroborates the relationship between the gait speed and the severity of knee OA.¹⁶

The specific objectives of this study were to determine the proportions of Kellgren and Lawrence (K & L) grades 3 and 4 severity of knee osteoarthritis amongst patients seen at University of Benin Teaching Hospital, to determine their gait speed and to assess the association between the Kellgren and Lawrence (K & L) grades 3 and 4 severity of knee osteoarthritis with the gait speed in patients seen at University of Benin Teaching Hospital.

Materials and Methods

Study design: The study was a hospital based descriptive cross sectional study.

Study duration: The study was carried out between August 2022 and July 2023

Study population: This included patients 40 years and above who attended the Orthopaedic clinic, UBTH and presented with knee osteoarthritis

Inclusion criteria

- I. Patients aged between 40 and 65 years with K&L grade 3 and 4 knee OA attending the UBTH Orthopaedic clinic.
- II. Patients who gave consent to participate in the study.
- III. Patients who have not used any medications that may influence gait speed within the last 12 hours.

Exclusion criteria

- I. Patients with secondary OA
- II. Morbidly obese Patients with a BMI ≥ 35 kg/m²
- III. Patients with cardiopulmonary disease that could influence gait speed
- IV. Patients with lower limb abnormalities including hip OA.
- V. Non-ambulatory patients
- VI. Patients with symptomatic degenerative spine disease
- VII. Patients who have had spine surgery or any joint arthroplasty in the lower limb
- VIII. Patients using walking aid
- IX. Patients with pathological gaits

Sampling method:

Patients were selected using convenience sampling technique, where all patients presenting with K & L 3 and 4 knee OA who met the inclusion criteria and gave consent were included in the study.

Sample size determination:

Sample size was determined using the Leslie Kish formula.

$$n = z^2 p q / d^2$$

Where n = sample size when population is greater than 10,000

z = standard deviation. It is 1.96 at 95% confidence level.

$$p = \text{prevalence of osteoarthritis} = 11.5\%^{17}$$

$$q = 1 - p = 0.89$$

$$d = \text{precision of accuracy of sample} = 5\%$$

$$n = 1.96^2 \times 0.115 \times 0.885 / (0.05)^2$$

$n=156$

Previous hospital records showed that an average of 80 patients with K and L knee OA is seen annually in the orthopaedic clinic. Therefore the corrected sample size for sample $<10,000$ is

$$Nf = n/1 + (n/N)$$

Nf = corrected sample size.

N = Size of population from previous hospital records.

$$Nf = 156/1 + 156/80$$

Nf = 52 patients for the study.

To accommodate for attrition, the sample was increased by 8% to make 56 patients for the study.

Ethical consideration

The study was in total compliance with the Helsinki declaration with written informed consent obtained from the respondents, explaining to them that all information would be kept confidential. Approval was obtained from the UBTH ethics committee.

Study procedure

The total sample size was fifty six patients with K & L 3 and 4 knee OA. All the patients were assessed and the gait speed undertaken by the author. An investigator proforma was used to record details of patients' personal and clinical data. Patients attending the UBTH orthopaedic clinic that met the inclusion criteria and gave consent were clerked using the proforma and recruited into the study. Also using their knee radiographs, the severity of knee osteoarthritis of each respondent were graded by the investigator using the Kellgren and Lawrence classification as follows into:

Grade 1(Doubtful)-Doubtful joint space narrowing and possible osteophytic lipping

Grade 2(Minimal)-Definite osteophytes and possible joint space narrowing

Grade 3(Moderate)-Moderate multiple osteophytes, definite narrowing of joint space and some sclerosis and possible deformity of bone ends.

Grade 4(Severe)-Large osteophytes, marked narrowing of joint space, severe sclerosis and definite deformity of bone ends.

Participants were requested to walk at their maximum speed on a flat surface (without the use of any walking aid) by instructing them to walk as fast as possible and safely, but without running after 15 minutes of rest. This was demonstrated by the investigator. The performance started with the

participant walking at their maximal pace from a starting point to a red cone which was 5 metres from the starting point in an unobstructed, dedicated corridor and this was timed using a stop watch. Timing started with the first step after the starting line and ended after the first step over the finish line using a stop watch. Immediately after completing the task, they were asked to repeat it. Gait speed was measured using metre per seconds as an average of the two performances.

Standard outcome measures

The knee radiographs of the respondents were used in determining the severity of knee osteoarthritis. This was graded using the Kellgren and Lawrence classification. Also respondent gait speed was measured in metre per seconds. These were entered into the individual proforma forms of the respondents.

Data analysis

Data was collected, coded and entered into an excel spreadsheet and analyzed using the software Statistical Package for Scientific Solutions (SPSS) version 22 [IBM Corp]. Point Biserial correlation test was used to correlate Kellgren and Lawrence (K & L) grades 3 and 4 with gait speed. Statistical significance was set at $p < 0.05$.

Results

A total of 56 subjects were included in this study, of which 60.7% (34) had K and L 3 knee OA (moderate) and 39.3% (22) had K and L 4 knee OA (severe). This study found out that the mean gait speed of respondents with K & L 3 and 4 knee OA were 1.09 ± 0.18 m/s and 0.75 ± 0.19 m/s respectively. The gait speed of respondents with moderate knee OA was found to be between 1 and 1.5m/s, while that of those with severe knee OA was found to be less than 1m/s. Also there was a negative correlation (inverse relationship) between radiographic severity of knee OA and gait speed.

Table I: Age and sex distribution of respondents

Variables	Frequency (N=56)	Percentage (%)
Age		
40-44	10	17.9
45-49	10	17.9
50-54	2	3.6
55-59	14	25
60 and above	20	35.7
Sex		
Female	44	78.6
Male	12	21.4

Sociodemographic of respondents

The mean age of the respondents was 54 ± 8 years. The age group 60 years and above constitutes majority of the respondents. The majority of respondents were female (78.6%).

Proportions of Kellgren and Lawrence (K & L) 3 and 4 knee OA amongst patients seen at UBTH

Figure 1 below shows that nearly two third of the respondents had moderate knee OA based on the Kellgren and Lawrence classification of severity of knee OA.

The gait speed of Kellgren and Lawrence (K & L) grades 3 and 4 severity of knee OA patients seen at University of Benin Teaching Hospital.

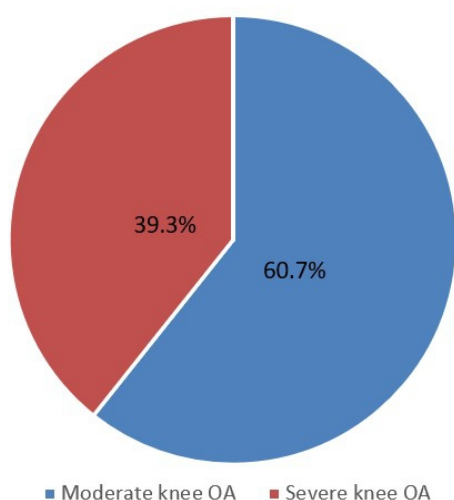


Fig.1: Pie chart showing the radiographic severity of knee OA.

Table II below shows the mean gait speed among the respondents. Those with K & L grade 4 knee OA had lower mean gait speed as compared with those with K & L grade 3 knee OA.

Table III below shows that majority of respondents with moderate knee OA (K & L 3) had gait speed of between 1 to 1.5m/s as compared to majority of respondents with severe knee OA (K & L 4) whose gait speeds were less than 1m/s.

Table II: Gait speed among grades of severity of knee OA.

K & L grades	Gait speed(m/s)		
	Mean	minimum	maximum
3 (Moderate)	1.09 $\pm$ 0.18	0.75	1.40
4 (Severe)	0.75 $\pm$ 0.19	0.50	1.17

Table III: Knee OA and gait speed range

Severity of Knee OA	Gait speed range		
	<1M/S	1-1.5M/S	Total
Moderate knee OA	6(17.6%)	28(82.4%)	34(100%)
Severe knee OA	20(90.9%)	2(9.1%)	22(100%)

Relationship between gait speed and the radiographic severity of knee OA (K&L grade 3 and 4)

In table IV below, a Point Biserial correlation (rpb) was run to determine the relationship between Kellgren and Lawrence (K & L) grades 3 and 4

Table IV: Relationship between gait speed and Kellgren and Lawrence severity of knee OA

Variable	Frequency (n=56) Gait speed
r _{pb}	-0.686
P value	0.001

r_{pb}=point biserial correlation

severity of knee OA and gait speed in patients seen at University of Benin Teaching Hospital. It shows a negative correlation between K & L grade 3 and 4 knee OA and gait speed. Thus indicating an inverse relationship between the severity of knee OA and the gait speed. This was statistically significant as p is less than 0.05.

Discussion

The aim of this study was to determine the association between gait speed and the radiographic severity of knee OA (K&L 3&4) amongst patients seen at University of Benin Teaching Hospital. A total of 56 respondents were recruited in this study. This study found an inverse relationship between gait speed and radiographic severity of knee OA (K & L 3 and 4). Respondents with severe knee OA (grade 4) had lower gait speeds compared to respondents with moderate knee OA (grade 3). The above findings were statistically significant thus rejecting the null hypothesis of no statistically significant association between gait speed and K & L 3 and 4 severity of knee OA and accepting the alternate hypothesis.

The mean age of the respondents was 54 ± 8 years with greater than one-third of them being 60 years and above. The incidence of knee OA was found to increase with age within the selected age range. This is similar to the findings in other studies which showed correlation between increased incidences of

knee OA with advancing age.^{4,6,9,17} This may follow the continuous use of the knee joints which results in repeated wear and tear of the joint with advancing age. The majority of the respondents were females with female to male ratio of 3.7 to 1. This indicate a greater prevalence of knee OA among females. A possible reason for this is due to the decline in oestrogen production as women age. This finding is similar to several other studies which showed that knee OA is more prevalent in females.^{4,6,9,15}

All respondents had advanced knee OA with over 60% of them having moderate knee OA. This is similar to the findings of Zeni et al where over sixty percent of the respondents had moderate knee OA.¹⁶ However a major limitation in their study is the grouping together of K & L 2 and 3 as moderate knee OA which may have influenced the outcome of their study. Also the majority of respondents with advanced knee OA in a study done by Mundermann et al had moderate (K & L 3) knee OA which is comparable to the findings in this study.¹⁹ They grouped the severity of knee OA with K&L3 only representing moderate knee OA similar to this study. Thus making their findings similar to this study.

Respondents with Kellgren 3 knee OA had higher gait speed than those with Kellgren 4 knee OA. The findings here is similar to that of Zeni et al in Delaware, USA where individuals with severe knee OA had a lower gait speed than those with moderate knee OA.¹⁶

Furthermore there was a strong inverse association between gait speed and radiographic severity of knee OA ($p < 0.05$). Individuals with radiographically severe knee OA (K&L grade 4) had lower gait speed as compared to individuals with moderate knee OA. Generally individuals with severe knee OA had gait speed of less than 1M/S as compared to those with moderate knee OA with gait speed of between 1 and 1.5M/S. This is because OA causes greater disability with increasing level of severity. The findings in this study are consistent with a previous study carried out in Delaware, USA which showed an inverse relationship between gait speed and severity of knee osteoarthritis.¹⁶ However, no difference was noticed in the gait speed among individuals with K&L grades 3 and 4 knee OA in a study done by Mundermann et al in the USA which is contrary to the findings in this study.¹⁹ The lack of difference in the gait speed as observed by Mundermann et al may be due to their inclusion criterion that was used as

only patients with medial compartment knee OA were recruited in their study; as compared to this study where pain from tricompartmental knee OA is more likely to have limited the gait speed.¹⁹ Also respondents were lumped together into two groups (those with K&L 2 and below compared with those with K&L 3 and above) and their sample size was small as compared to that of this study.¹⁹ Most other studies on gait speed and knee OA did not compare radiographic severity with it.^{6,15,20}

Conclusions

About two-third of the respondents with advanced knee OA seen at the university of Benin Teaching Hospital had Kellgren and Lawrence (K & L) 3 knee OA, while about one-third of them had K & L 4 knee OA. The gait speeds in individuals with K&L 3 and 4 knee OA were 1.09 ± 0.18 m/s and 0.75 ± 0.19 m/s respectively. There was an inverse significant relationship between gait speed and radiographic severity of knee OA in the study population. Thus the gait speed can be used as a simple tool to grade advanced knee OA in communities where facilities for imaging are not readily available facilitating early referrals. Further study preferably a multicentre study on the use of the Kellgren and Lawrence grading system of knee OA as a predictor of gait speed is recommended to further validate the findings in this study.

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Conflicts of interest

There are no conflicts of interest.

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