Original Research Article

Evaluation of Age, Gender, Body Mass Index and Gait Characteristics in Knee Osteoarthritis Patients

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ABSTRACT

Background: Knee osteoarthritis is among one of the most common disabling conditions worldwide. It is associated with a number of risk factors such as age, gender and obesity. The walking pattern of individuals is also affected during the disease progression.
Objective: To evaluate certain factors such as age, gender and Body Mass Index along with gait characteristics such as step length, stride length, cadence and walking speed in patients with knee osteoarthritis.
Methods: A total of 84 subjects above forty years of age with orthopedician diagnosed osteoarthritis of knee who reported to the Physiotherapy out-patient department of Guru Jambheshwar University of Science & Technology, Hisar were included in the study. The age, height, weight was noted and Body Mass Index was calculated. Step and stride length, cadence and walking speed were measured using footprint method. Independent t-test was used to compare the above characteristics between males and females and gait characteristics between different age groups using SPSS software.
Results: Female gender and obesity displayed a greater association with knee osteoarthritis as 39.5% males and 60.4% females belonged to the age group of 41-50 years while 46% males and 64% females had Body Mass Index>25-30 kg/m^2. Males had longer step length, stride length and faster walking speed than females. Elder age group had lower cadence and slower walking speeds.
Conclusion: Age, gender, Body Mass Index and gait characteristics should be considered while preparing exercise regimes along with inclusion of weight control programmes in knee osteoarthritis patients to achieve better outcomes.
Key Words: Knee osteoarthritis, gait, obesity, BMI, age, gender

INTRODUCTION

Osteoarthritis (OA) is one of the major orthopedic conditions accountable for disabling a vast population of the world at present. [1-3] This condition involves breakdown of the articular cartilage and leads to the development of peri-articular osteophytes, sub-chondral sclerosis and cysts, narrowing and loss of joint space thus restricting the normal joint range of motion. [4] Primary osteoarthritis has a predisposition for the large weight bearing joints of the body such as knee and hip. Knee joint is among one of the main joints to be chiefly affected by degenerative joint disease. The reports of the third National Health and Nutrition Examination Survey (NHANES III) state that about 37 % of the subjects older than 60 years exhibit radiographic knee osteoarthritis. [5] The prevalence of symptomatic knee osteoarthritis has been reported to be 10% in

males and 13% in females. [6]

This number is continuously on the rise because of association with certain predisposing factors leading to further worsening of the situation. The risk factors which predispose an individual to knee osteoarthritis are age, obesity, and female gender, sedentary way of living, muscular problems leading to muscular weakness or imbalance and certain occupations. [7] The involvement of weight bearing joints plays a major role in disturbing the gait pattern of the affected individuals. It has been documented that the knee joint is subjected to increased loads during walking. [8] Previous studies have reported biomechanical alterations in the lower extremity in individuals suffering from osteoarthritis of knee joint resulting in deviations in majority of the gait characteristics. This leads to a change in the walking pattern in patients suffering from knee osteoarthritis. [9] Such factors play an important role in the genesis of the disease and influence the prognosis.

The aim of the present study was to have a better understanding of the demographic factors such as age and gender along with body mass index (BMI) and certain gait characteristics such as step length, stride length, cadence and walking speed in patients with osteoarthritis of the knee joint. A clear picture of these traits could help in prevention of such crippling diseases and determine factors to be taken into consideration during the management of the patients.

METHODOLOGY

This paper puts forth the basic attributes such as age, gender, BMI and gait characteristics of knee osteoarthritis patients from a research trial conducted at Department of Physiotherapy, Guru Jambheshwar University of Science & Technology, Hisar (Haryana). A total of 84 subjects with orthopedician diagnosed osteoarthritis of knee who reported to the Physiotherapy out-patient department of the University were included in the study.

Subjects were only included in the study if they were more than forty years of age with a diagnosis of knee osteoarthritis. The exclusion criteria included those having any inflammation or infection of knee joint, history of recent injury, surgery or deformity in lower limb, skin complaints around knee, those dependent on use of walking aids, those referred for replacement surgeries, history of heart disease or neurological disorders. In case of bilateral knee osteoarthritis, greater symptomatic knee was taken into consideration for the measurements. Patient found unsuitable for participation in the study due to any other reasons were also excluded. The ethical permission for the conduct of the study was granted by the Institutional Ethical Committee (letter no. PTY/2015/800, dated 03/11/2015). Patients were informed and given clarifications regarding the study procedure before participation in the study. All the subjects gave their signed informed consents.

Procedure

The age, height and weight were noted for all the subjects recruited in the study using standard measurement procedures. Body mass index was calculated and noted for all subjects by dividing weight (kg) of the subject by square of height (m^2).Gait characteristics such as step and stride length, cadence and walking velocity were measured by the help of footprint method. [10] The step length, stride length and velocity were recorded on a 10 meter path on the floor. The step length was measured (in cm) as the distance between the geometric heel center of footprint of one extremity and the geometric heel center of the footprint of the opposite extremity. The stride length was measured (in cm) from the line of progression between heel points of two succeeding footprints of the same extremity. Walking velocity was calculated by dividing ten meter distance by the time taken to traverse the 10 meter path. Cadence was calculated as the number of steps taken by the subject per minute. The subjects were made to walk in a straight corridor for one

minute for calculating cadence. The subjects were given a few practice trials before the start of measurements in order to familiarize them with the procedure. The subjects were asked to walk at their normal, self-selected speed during the measurements.

Statistical Analysis

Data was analyzed using SPSS software (version 21). The results were expressed in terms of mean, standard deviation and percentages for all the basic and gait variables. Independent t-test was used to compare the differences among male and female subjects for age, height, weight and gait parameters namely step length, stride length, cadence and walking speed. Different age groups were also compared for gait variables using independent t-test. Level of significance was set at p≤0.05.

RESULTS

The present study was conducted on 84 subjects suffering from knee osteoarthritis comprising of 51 females and 33 males. The mean age, height, weight, BMI and gait parameters such step length, stride length, cadence and walking speed are shown in Table 1. Independent t-test was used to compare demographic characteristics of males with females (Table 2). The mean age, height and weight of the males was 53.87±9.35years, 168±7.57cm and 79.84±10.37kg respectively. The female subjects had a mean age, height and weight of 52.08±7.94 years, 156.15±6.78 cm and 70.85±10.27 kg respectively. Significant differences were seen for height and weight between males and females whereas there were no significant differences seen in the age for both genders.

The males and females were further classified into different age groups (Table 3). 17 males(39.5%) and 26 females(60.4%) were in the age group of 41-50 years, 7 males (31.8%) and 15 females(68.18%) were in the age group of 51-60 years, 7 males(41.17%) and 10 females(58.82%) were in the age group of 61-70 years. Only two male subjects (100%) were in the age group of more than 70 years.

Further grouping of male and female subjects was done under different BMI categories which were similar to the classification given by World Health Organization Asia Pacific guidelines [11] (Table 4): Normal: 18.5-22.9 kg/m^2, overweight: 23-25kg/m^2, obese I: >25-30 kg/m^2 and obese II: > 30 kg/m^2.Out of 84 subjects, 1 male (50%) and 1 female (50%) had normal BMI, 2 males (28.57%) and 5 females (71.43%) were overweight, 23 males (46%) and 27 females (64%) fell under obese I category while 7 males (28%) and 18 females (72%) came under obese II category. Thus, out of 84 subjects, 50 subjects belonged to the category of obese I with BMI >25-30 kg/m^2. The obese II category with BMI >30 kg/m^2 had 25 subjects. A total of 7 subjects were overweight with BMI ranging between 23-25 kg/m^2 while only two subjects fell under category of normal BMI within a range of 18.5-22.9 kg/m^2.

The differences in gait variables between males and females are shown in Table 5.The mean step length, stride length, cadence and walking speed for males was 56.57±4.82 cm, 111±9.44 cm, 100.94±5.52 steps/min and 0.92±0.11 m/s respectively. In case of females, the mean step length, stride length, cadence and walking speed was 52.78±4.70 cm, 102.45±9.29 cm, 100±3.83 steps/min and 0.87±0.10 m/s. Significant differences were seen for step length; stride length and walking speed among males and females. However, no significant differences were seen in cadence for males and females.

The subjects were broadly classified into two age groups of 41-55 years and 56-72 years for the purpose of comparison since there were only two subjects falling under the category of more than 70 years (Table 6). Independent t- test was used to compare the gait parameters between both age groups. The mean step length and stride length for the subjects between age group of 41-55 years was 54.29±5.27cms and 105.75±10.86cms respectively. In the age group of 56-72 years, the mean step length

and stride length was 54.23±4.78cm and 105.9±9.05cm respectively. No significant differences were seen between both the age groups for step length and stride length. The mean cadence and walking speed for age group of 41-50 years was 101.87±4.1cm and 0.93±0.1m/s respectively. However, the mean values for cadence and walking speed in case of 56-72 years age group was 97.66±4.1cm and 0.82±0.08m/s respectively. Significant differences were seen in both the age groups for cadence and walking speed.

Table1.Basic demographic and gait characteristics of subjects with knee osteoarthritis

Variable	Mean ± SD
Age(years)	52.78±8.51
Height(cm)	160.80±9.15
Weight(Kg)	74.38±11.16
BMI(Kg/m^2)	28.71±3.13
Step length(cm)	54.27±5.01
Stride length(cm)	105.81±10.19
Cadence(steps/min)	100.36±4.56
Walking speed(m/s)	0.88±0.107

Table2. Demographic characteristics of male and female subjects

Variables	Males (n=33)	Females (n=51)	p*
Age	53.87±9.35	52.08±7.94	0.347[NS]
Height(cm)	168±7.57	156.15±6.78	0.000[S]
Weight(kg)	79.84±10.37	70.85±10.27	0.000[S]

p≤0.05, NS- non significant, S-significant

Table3. Classification of male and female subjectsas per different age groups

Gender	41-50years (N= 43)	51-60years (N=22)	61-70years (N= 17)	>70years (N=2)
Male	17(39.5%)	7(31.8%)	7(41.17%)	2(100%)
Female	26(60.4%)	15(68.18%)	10(58.82%)	0

Table4. Classification of male and female subjects as per different BMI categories

Gender	Normal (18.5-22.9 kg/m^2) (N= 2)	Overweight (23-25kg/m^2) (N=7)	Obese I (>25-30 kg/m^2) (N= 50)	Obese II (> 30 kg/m^2) (N=25)
Male	1(50%)	2(28.57%)	23(46%)	7(28%)
Female	1(50%)	5(71.43%)	27(64%)	18(72%)

Table5. Gait characteristics of male and female subjects

Variables	Males (n=33)	Females (n=51)	p*
Step length(cm)	56.57±4.82	52.78±4.70	0.001[S]
Stride length(cm)	111±9.44	102.45±9.29	0.000[S]
Cadence(steps/min)	100.94±5.52	100±3.83	0.359[NS]
Walking speed(m/s)	0.92±0.11	0.87±0.10	0.03[S]

p≤0.05, NS- non significant, S-significant

Table6. Comparison of gait variables among different age groups

Variables	41-55years (Mean±SD)	56-72years (Mean±SD)	p*
Step length(cm)	54.29±5.27	54.23±4.78	0.957[NS]
Stride length(cm)	105.75±10.86	105.9±9.05	0.952[NS]
Cadence(steps/min)	101.87±4.1	97.66±4.1	0.000[S]
Walking speed(m/s)	0.93±0.1	0.82±0.08	0.000[S]

p≤0.05, NS- non significant, S-significant

DISCUSSION

Osteoarthritis of the knee has a profound impact on the daily functional activities of the patients suffering from this disabling disease. It has been reported that a large number of people affected by knee osteoarthritis have problems in walking and other routine activities in which weight bearing and ambulation is involved. Also, there are other factors such as age, obesity and female gender which are known to be associated with such type of degenerative diseases. This study attempts to present forth the basic demographic and gait characteristics of the patients diagnosed with knee osteoarthritis.

The present study included 84 subjects out of which 51 subjects were females while 33 were males. This study found gender differences in height, weight and gait characteristics among the study subjects. The comparison of basic physical characteristics such as age, height and weight revealed differences among males and females. Comparison between both genders for age did not show any significant differences although the mean age of females was lower as compared to males. Significant differences were seen in the height and weight of males and females with males being taller and heavier than females. This study was undertaken in the Hisar city of Haryana, a northern state of India. Height and weight differences among the genders are controlled by factors such as race, ethnicity, climatic conditions, diet, nutrition and socio-economic status. Height is usually influenced by both genetic and environmental factors whereas weight and BMI are a manifestation of the nutritional status. [12,13] Thus, these variations can be attributed to the general anthropometric characteristics of males and females of this region with males being taller and possessing greater body weights. Also, these gender differences in anthropometrics of knee osteoarthritis subjects are further strengthened by the findings of previous researches. [14]

The association of age was studied by dividing the male and female subjects into different age groups. It was surprising to see that 51.19% subjects (17 males and 26 females) were between the age group of 41-50 years which evidences the current rise in diagnosed knee osteoarthritis in the younger and middle age group. Almost an equivalent number of subjects were present in divided distribution among the age groups of 51-60 years, 61-70 years and more than 70 years. About 48.81% of the subjects were above 50 years of age. Females were found to be in greater number than males under all the age categories thus showing a clear dominance of the female gender among the subjects. Our findings are supported by the findings of a previous research done by Sowers et al. [15] They reported that radiographically defined prevalence of knee OA was 15% in the age group of 40-44 years and 13.3% and 14.3% in the age groups of 45-49 and 50-53 years respectively. They also reported that the risk factors associated with older populations were also present in this younger group of females. Another study done by Amaoko and Pujalte stated that although OA is considered as a disease of the elderly but it may also affect young individuals. [16] It is usually difficult to diagnose knee osteoarthritis in young adults because of their increased tolerance to pain and hence remains untreated. They state that the etiology of OA varies according to the population involved and in the case of young individuals, factors such as heredity, obesity; occupation and gender appear to play a greater role in the development of osteoarthritis. This was the case in the present study which is further strengthened by the results seen in the study. The dominance of female gender in the present study is supported by a previous study which states that differences exist in the knee anatomy and structure between both the genders. [17] Moreover, females displayed different kinematics in comparison to men. Previous knee injury and hormonal changes are also major factors which contribute in the evolution of knee osteoarthritis. A combination of these factors makes females more likely to develop knee osteoarthritis in comparison to males.

Other significant finding of the present study discloses and reinforces the strong association of obesity with knee osteoarthritis since a significant proportion i.e. 59.5 % of the study subjects demonstrated a BMI >25-30 kg/m^2 and 29.76% demonstrated a BMI more than 30kg/m^2. Around 8.3% of the subjects were overweight. These findings are consistent with past literature. Earlier studies have demonstrated obesity as a primary risk factor for knee osteoarthritis. Biomechanical and metabolic mechanisms have been hypothesized to explain the association between obesity and knee osteoarthritis. [18,19] As per the biomechanical mechanism, obesity increases the load and thus a greater impact is suffered by articular cartilage of the knee joint leading to fibrillation and degradation. Abnormal loads may also lead to structural and mechanical changes along with alterations in the composition of hyaline cartilage leading to cartilage erosion. Another theory states that the mechanoreceptors present on the surface of chondrocytes are activated by abnormal loads and thus lead to production of mediators such as prostaglandin and nitrous oxide which further results in oxidative stress, inflammation and tissue failure. Another biomechanical factor was quadriceps muscle strength. Obesity results in weakness of quadriceps muscle leading to osteoarthritis, since greater quadriceps strength plays a protective role for the cartilage. The metabolic mechanisms which may be instrumental in the association between obesity and knee osteoarthritis hypothesize that adipose tissue secretes cytokines and adipocytokines such as leptin, resistin and adiponectin which disturb the cartilage homeostasis. Thus, it can be concluded that weight reduction programmes will play a significant role in the management of knee osteoarthritis.

Upon analyzing the gait variables, it was observed that male subjects had longer step length and stride lengths. Although, significant differences in walking speed were observed with males demonstrating greater walking speeds than females, no differences were seen in cadence between both genders. The results of the present study are consistent with findings of earlier researches. A study investigating gender differences in osteoarthritic gait documented differences in stride length of males and females with knee osteoarthritis. [14] The longer step length and stride length may occur as a result of the height differences between male and female subjects. These differences may disappear on normalization of step and stride length with height which was not done in the present study. The results of the present study are in partial agreement with the results of another study done to compare gait patterns in male and females with osteoarthritis of knee. [20] It stated that men and women had the same walking speed, cadence and step length. Thus, although, the participants in our study displayed differences in step and stride lengths as well as walking speed, cadence was unaffected by gender. However, these previous researches demonstrated differences in biomechanics and gait cycles between both genders, which could play a role in the findings of our study.

Another finding of the present study was that a reduction in the walking speed and cadence was seen with increasing age. The subjects were divided broadly into two age groups of 41-55 years and 56-72 years for the purpose of comparison. No significant differences were seen for step length and stride length among the two age groups. However, significant differences were seen in cadence and velocity on comparison of these age groups, with the age group of 56-72 years displaying lower cadence and slower walking speed as compared to subjects in the age group of 41-55 years, thus revealing the impact of age on gait parameters. This finding can be explained by the results of a previous study

which concluded that certain gait parameters such step length and cadence were reduced in patients with knee osteoarthritis. [20] These altered spatio-temporal parameters occurred as a result of adaptation in an attempt to reduce pain by reducing knee moments. Another group of researchers performed a study which investigated kinetic and kinematic variables of gait in medial knee osteoarthritis patients. [21] They also found a decline in the walking velocity along with lower cadence and shorter stride length. Their study stated that mechanical changes occur in the early medial knee osteoarthritis and a shorter stride length was again a part of the unloading mechanism while walking adopted by individuals suffering from knee osteoarthritis. A study investigating the altered lower limb movements and muscle activation patterns in knee osteoarthritis concluded that persons with OA of knee joint employed distinct movement and muscle activation patterns while walking. However, all these adaptive mechanisms interfered with the ability of knee joint to disperse loads which further lead to the progression of the disease. Otherwise also, age related changes such as slow walking speeds have been observed in older adults. The age related decline in walking speed as demonstrated by the present study is consistent with the findings of a study investigating age associated changes in gait pattern using different walking speeds. [22] They deduced that walking speed reduced with older age during usual walking speed tasks, fast speed walking tasks as well as in post activity walking tasks.

However, our results were also in partial contradiction with their results as they also reported a decline in the stride length with age whereas in case of our study, there were no significant differences seen in both age groups. They also reported an increase in cadence for all the tasks which was found to be lower in our study in the older age group. This could possibly be due to the fact that the mean age of the participants in the present study was only

52.78 which is considerably less as compared to their study. Moreover, the subjects in our study were knee osteoarthritis patients and their study was a longitudinal study which simply included elderly people without a clear diagnosis of arthritis. It has already been documented in previous researches that gait differences exist in people with and without knee osteoarthritis. [20,21]

CONCLUSION

The present study concludes that age related and gender differences along with gait variations exist in knee osteoarthritis patients. There is a rise in patients with knee OA among the younger and middle age group. Obese persons and particularly females are more susceptible to knee osteoarthritis. Females exhibited shorter step length, stride length and walking speeds as compared to males. Walking speed and cadence also reduced with increasing age. Therefore, the general population, particularly females should be educated to prepare well in advance during early years to take adequate measures for prevention of knee osteoarthritis. Weight control programmes should also be definitely integrated with exercise protocols as a part of the holistic approach in the management of knee osteoarthritis. Thus, the exercise regimes developed for knee osteoarthritis should take the demographic factors such as age, gender, BMI and gait characteristics into consideration in order to achieve better outcomes.

Conflict of interest: Nil

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