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ORIGINAL RESEARCH ARTICLE

Association of Body Mass Index with Kellgren–Lawrence Grading of Knee Osteoarthritis – A Cross-sectional Study

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ABSTRACT

Background: Osteoarthritis is the most prevalent form of arthritis causing disability, particularly in elderly population. Aging, female sex, obesity, and possibly nutritional deficiencies trigger the pathogenesis of osteoarthritis. This study aims to identify the association of body mass index (BMI), with knee osteoarthritis grading viewed from Kellgren–Lawrence (KL) criteria in participants with osteoarthritis of the knee joint.

Methods: This research is a cross-sectional study using analytical approach in 70 participants diagnosed with Knee Osteoarthritis at Vaidyaratnam Ayurveda College, Ollur, Thrissur. BMI was calculated by measuring the height and weight of participants. Grading of knee OA based on KL criteria was assessed from the antero-posterior X-ray radiograph.

Results: Of 70 participants, 81.4% were female and 31.4% were in the age group of 50–55 years, 27.1% in the age group of 61–65 years. Among the total 70 participants, 45.7% belong to overweight category, 28.6% were obese. Knee OA grading based on KL criteria indicates that the most frequent grade is Grade 2 with 34.3% followed by Grade 3 30%. Spearman rank correlation showed a positive correlation between BMI and degree of joint damage, which was statistically significant at 0.01 level ($r = 0.491^{**}$, $P < 0.001$).

Conclusion: The higher the BMI value, the heavier the grading of OA of the knee.

1. INTRODUCTION

Osteoarthritis, the predominant form of arthritis causing disability, especially among the geriatric population, ranks as the 10th leading cause of nonfatal burden. In India, it stands as the second most prevalent rheumatologic issue, affecting 22–39% of the population.[1] Notably, obesity is a widely acknowledged and potent risk factor for knee osteoarthritis, exhibiting a stronger association in women compared to men. The relationship of weight to the risk of disease is linear, so that with each pound increase in weight, there is a commensurate increase in risk.[2] Weight loss in women has been shown to decrease the likelihood of developing symptomatic osteoarthritis.

Remarkably, two-thirds of obese individuals contend with osteoarthritis, and the incidence of OA rises with increased body mass index (BMI).

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Moderate dynamic mechanical loading is crucial for maintaining joint homeostasis, ensuring the integrity of articular cartilage during routine daily activities. However, abnormal and excessive mechanical loading can disrupt cartilage homeostasis, leading to the deformation of normal joint morphology and hastening the progression of OA.[3]

The impact of increased body weight on weight-bearing joints varies depending on their anatomical configuration. Being a hinge joint, the knee joint and surrounding tissues counteract large shearing, compressive, and axial loading forces. Any dysfunction in these surrounding tissues may amplify the stress on the joint, exacerbating underlying arthritic disease.

In obese participants, increased thigh girth induces greater hip abduction, circumferential swing phase, and varus alignment to avoid thigh contact during walking. This, in turn, reduces the effective loading area on the knee joint accelerating the stress on the medial compartment of the knee joint potentially causing structural damage.[4] Abnormal loads to Knee joint attributed to factors such as obesity, joint instability, or trauma and can result in alterations to the composition, structure, and mechanical properties of articular cartilage.

Studies have proved that reduced quadriceps strength relative to body weight constitutes a risk factor for knee OA. Hilton *et al*. confirmed this finding suggesting that excess adipose tissue infiltration in muscles of obese individuals might be a contributing cause.[5] It is worthwhile to note that the risk of combined obesity and muscle dysfunction is heightened in the elderly, who are already at an increased risk of osteoarthritis.

The focus of this study is to explore the dependency of BMI with knee osteoarthritis grading viewed from Kellgren–Lawrence (KL) criteria in participants with osteoarthritis of the knee joint attended in the Kayachikitsa OPD of Vaidyaratnam Ayurveda College, Ollur, Thrissur, Kerala, India.

2. METHODS

2.1. Study Design and Study Setting

A cross-sectional analytical study conducted at the Kayachikitsa OPD of Vaidyaratnam Ayurveda College, Ollur, Thrissur, Kerala, India, for 61 days from September-October 2023.

2.2. Population and Sample

The population included 70 subjects aged between 50 and 70 years who fulfilled the clinical diagnostic American College of Rheumatology criteria[6] for knee osteoarthritis with the involvement of unilateral or bilateral knee. Participants with other forms of joint diseases such as rheumatoid arthritis, gout, with anatomical deformity, with a history of acute joint trauma, fractured joint, and recurrent patellar displacement, severe knee bursitis, uncontrolled diabetes mellitus, uncontrolled hypertension, hypercholesterolemia, pregnant and lactating mothers were excluded from the study.

2.3. Sampling Procedure

Purposive Sampling.

2.4. Data Collection Method

Data regarding gender, age, and the affected knee were recorded using personal interview and clinical examination. BMI data is based on body weight and height measurements. Measurement of height in meters and weight in kilograms were measured with body weight scales and stadiometers with each subject in standing position. BMI was calculated by Quetelet index (weight in kilograms divided by the square of height in meters (kg/m^2) and participants were classified as underweight with BMI < 18.5, normal with BMI 18.5–24.9, overweight 25.0–29.9 and obese with BMI > 30.0. The presence of definite osteophytes or joint space narrowing was used to classify knee Osteoarthritis. Grading of knee OA based on KL criteria[7] was determined by the Antero-posterior X-ray radiograph of the affected knee joint. The assessment of participants was taken by personal interview, clinical examination, X-ray of the affected knee anteroposterior view in standing position.

2.5. Data Analysis

All the data collected were entered into MS Excel master sheet and subjected to statistical analysis. Frequency distributions of different variables were obtained. Data analysis was performed using SPSS (IBM SPSS Statistics for Windows, Version 21, and Released 2012). Statistical analysis was performed using descriptive statistical calculations, frequency distribution, and statistical tests. Spearman rank correlation was used to find the degree of association between BMI and Grading of Knee OA [Table 1].

3. RESULTS

In the present study, out of the 70 participants, 22 were in the age group of 50–55 (31.4%), 19 participants (27.1%) were in the age group of 61–65. Women contribute 81.4% of the total, *i.e.*, 57 participants and 13 (18.6%) were men. Among the total, 32 (45.7%) belong to overweight category, 20 (28.6%) were obese. Participants with normal BMI contribute 25.7% of the total. Of 70 participants sampled with knee OA, 24 (34.3%) participants had Grade 2 degenerative changes as per KL criteria, 21 (30.0%) had Grade 3 knee OA and 6 (4.6%) participants had Grade 4. In this study, 39 (55.7%) had Unilateral knee joint pain, whereas 31 (44.3%) had bilateral involvement of knee OA [Table 2].

Among the 18 participants with normal BMI, 10 (55.6%) had Grade 1 degenerative changes in KL Scale of knee osteoarthritis. 4 (22.2%) had Grade 2 and Grade 3 changes each. There were no participants with Grade 4 degenerative changes in normal BMI category. Of the 32 overweight participants, 16 (50%) had Grade 2 degenerative changes in X-ray, 8 (25%) had Grade 1, 6 (18.8%) participants had Grade 3, 2 (6.3%) had Grade 4 degenerative changes in X-ray as per KL scale. Among the 20 obese participants, 11(55%) had Grade 3 degenerative changes, 4 (20%) participants each had Grade 2 and Grade 4 degenerative changes. Only 1 (5%) participant in obese category had Grade 1 degenerative changes in X-ray as per KL Scale of Knee OA [Table 3].

Spearman rank correlation was used to determine the association between BMI and grading of degenerative changes as per KL criteria among 70 participants. There exists a positive correlation between BMI and degree of joint damage, which was statistically significant at 0.01 level ($r = 0.491^{**}$, $P < 0.001$).

4. DISCUSSION

Among the total 70 participants, the highest proportion of Knee OA sufferers in this study 22 in the age group of 50-55 years (31.4%), 19 participants (27.1%) in the age group of 61-65 years. This is in line with a study conducted on the epidemiology of Knee Osteoarthritis in India and related factors, found that the prevalence was highest among the age group of 60 and above and lowest in people in the age group of 40–50 years[8] (P = 0.001). This supports the fact that severity of this degenerative disease increases with age. Muscles and other associated structures that bridge the joint become weaker with age.

Of the total sample, 57 (81.4%) participants of the present study were women, and 13 (18.6%) were men. Females tend to have more severe knee OA, particularly after menopausal age due to estrogen deficiency.[9] In females, sex steroids decrease up to a great extent immediate after menopause. Cartilage degeneration is found to be more severe in postmenopausal women when compared to pre- and perimenopausal women.[10]

In this study, 45.7% belong to overweight category, 28.6% were obese. This points to the fact that being overweight and heavy built is a key factor for knee OA and substantial grounds for the concern of disease severity. Obesity is considered as a primary risk factor for incident knee osteoarthritis.[11] Due to increased mechanical loading of the joints, it has been speculated that cytokines released from adipose tissue may also play a role in contributing to the disease.[12]

Based on KL grading, the highest proportion of participants with knee OA in this study was Grade 2 (34.3%), followed by Grade 3 (30%), Grade 1 (27.1%), and Grade 4 (8.6%). As per a meta-analysis study showed that with every 5 kg of weight gain conferring a 36% increase in the risk of knee OA. Results from the Framingham study have demonstrated that weight loss reduces the risk for OA in women.[13]

Among the total, 55.7% participants had unilateral involvement of Knee joint pain, and the rest had bilateral knee pain. Osteoarthritis may have an asymmetrical onset but it has a tendency to affect both joints with time.[14] Abnormal loading in the unaffected knee of participants with unilateral knee osteoarthritis, may accelerate disease in other joints due to changes in gait.[15]

From the analysis of the correlation of BMI with the knee joint OA grading, there exists a significant correlation with r = 0.424** and $P < 0.005$. In overweight category, 50% participants had grade 2 degenerative changes in X ray as per KL criteria and 18.8% had Grade 3 changes, whereas in obese category, 55% participants had Grade 3 degenerative changes. Grade 2 and Grade 4 degenerative changes were seen in 20% participants each. 10 participants with Normal BMI had Grade 1 degenerative changes, 4 participants each with Grade 2 and Grade 3 changes in X-ray. As severity of Knee OA progress symptomatically, degenerative changes can also be seen radiographically. Osteoarthritis of the knee joint will increase gradually in accordance with the increase in BMI. It was found that as the BMI increases, from overweight to obese; greater will be the degenerative changes radiographically as per KL scale for Knee OA.

5. CONCLUSION

There exists a significant positive correlation between BMI and KL degree in participants with Knee Osteoarthritis and it was concluded that the higher the BMI value, the heavier the grading of OA of the knee.

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7. AUTHORS' CONTRIBUTIONS

All the authors contributed equally to design and execution of the article

8. FUNDING

Nil

9. ETHICAL APPROVALS

All procedures for this study have been approved by the Institutional Ethics Committee Vaidyaratnam Ayurveda College, Ollur, Thrissur, with Ref No: 16/10/08/2021/ECC.

10. CONFLICTS OF INTEREST

Nil.

11. DATA AVAILABILITY

This is an original manuscript and all data are available for only review purposes from principal investigators.

12. PUBLISHERS NOTE

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Table 1: Association of BMI with KL 3 Knee OA

KL grading	BMI range						*r* value	*P*-value
	Normal		Overweight		Obese			
	Frequency	Percent	Frequency	Percent	Frequency	Percent		
KL 1	10	55.6	8	25.0	1	5.0	0.491**	<0.001
KL 2	4	22.2	16	50.0	4	20.0		
KL 3	4	22.2	6	18.8	11	55.0		
KL 4	0	0.0	2	6.3	4	20.0		
Total	18	100	32	100	20	100		

**Significant at 0.01 level. KL: Kellgren–Lawrence, BMI: Body mass index

Table 2: Distribution of the sample (*n*=70)

Variable	Frequency	Per cent
Age group (in years)		
50–55	22	31.4
56–60	18	25.7
61–65	19	27.1
66–70	11	15.7
Gender		
Male	13	18.6
Female	57	81.4
BMI (Kg/m^2)		
Normal	18	25.7
Overweight	32	45.7
Obese	20	28.6
Kellgren–Lawrence scale		
Grade 1	19	27.1
Grade 2	24	34.3
Grade 3	21	30.0
Grade 4	6	8.6
Side affected		
Unilateral	39	55.7
Bilateral	31	44.3

Table 3: Kellgren–Lawrence grading scale

Grade	Radiologic finding
Grade 0	No radiographic features of OA present
Grade 1	Doubtful joint space narrowing and possible osteophyte lipping
Grade 2	Definitive osteophytes and possible joint space narrowing on anteroposterior weight-bearing radiograph
Grade 3	Multiple osteophytes, definite joint space narrowing, sclerosis, possible bony deformity
Grade 4	Large osteophytes marked joint space narrowing, severe sclerosis and definite bony deformity