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ORIGINAL RESEARCH

Association of Body Mass Index With Radiographic Severity, Pain, Physical Function, and Knee-Related Quality of Life in Knee Osteoarthritis: A Registry-Based Pilot Study

Riya Gurudasani [1*], **Deepak Anap** [2]

[1] *Postgraduate Student, Department of Musculoskeletal Physiotherapy, Maharashtra, India*

[2] [2] *Professor and Head, Department of Musculoskeletal Physiotherapy, Maharashtra, India*

*Correspondence: Riya Gurudasani <rpgurudasani3333@gmail.com>

ABSTRACT

Background: Knee osteoarthritis (KOA) is a major cause of pain and disability, and obesity is an important potentially modifiable factor in its clinical burden. This pilot study examined the association of body mass index (BMI) with radiographic severity, pain, physical function, and knee-related quality of life among patients with KOA enrolled in an online clinical registry.

Methods: This observational, registry-based pilot study included 20 adults aged 40 years or older with clinically and/or radiographically confirmed KOA. BMI and Kellgren-Lawrence (KL) grade were obtained from the registry. Pain, physical function, and quality of life were assessed using the corresponding Knee Injury and Osteoarthritis Outcome Score (KOOS) domains. Because the data were non-normally distributed, Spearman rank correlation was used to examine associations between BMI and each outcome. Statistical significance was set at $p < 0.05$.

Results: Participants had a mean age of 74.55 ± 4.19 years and a mean BMI of 32.21 ± 1.57 kg/m²; all participants met BMI criteria for obesity. BMI showed a strong positive correlation with KL grade (Spearman rho = 0.7731, 95% CI 0.4919 to 0.9083; $p < 0.0001$). Higher BMI was also associated with lower KOOS quality-of-life scores (rho = -0.8011, 95% CI -0.9203 to -0.5456; $p < 0.0001$), lower KOOS pain scores (rho = -0.4909, 95% CI -0.7726 to -0.0477; $p = 0.0280$), and lower KOOS physical-function scores (rho = -0.4614, 95% CI -0.7568 to -0.0096; $p = 0.0406$). Because higher KOOS scores indicate better status, the negative correlations correspond to worse patient-reported outcomes at higher BMI.

Conclusion: Within this small cohort of patients with KOA and obesity, higher BMI was associated with greater radiographic severity and poorer pain, physical-function, and quality-of-life scores. The findings are exploratory and do not establish causality. Larger studies including a broader BMI range and adjustment for potential confounding factors are required to confirm these associations.

Keywords: Body mass index; Knee osteoarthritis; Kellgren-Lawrence grade; KOOS; Obesity; Pain; Physical function; Quality of life

Introduction

Knee osteoarthritis (KOA) is a chronic whole-joint disorder characterized by pain, stiffness, loss of function, and progressive limitations in mobility and participation. It is among the most important musculoskeletal causes of disability in older adults, and its clinical expression reflects a combination of structural joint change, pain processing, muscle function, physical activity, and psychosocial factors [1].

Obesity is one of the most consistently identified modifiable factors associated with KOA. Meta-analyses of observational and prospective studies have shown that higher body mass index (BMI) is associated with an increased risk of developing knee osteoarthritis [2,3]. The relationship is biologically plausible through both mechanical and metabolic pathways. Greater body mass increases joint loading during weight-bearing activities, while adipose tissue may contribute to low-grade systemic inflammation through adipokines and other inflammatory mediators that can influence cartilage, synovium, and subchondral bone [4,5].

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The clinical consequences of obesity in established KOA extend beyond radiographic change. Studies in adults with knee osteoarthritis have reported worse pain, physical health, gait characteristics, and other functional outcomes across increasing levels of obesity [6,7]. However, the relationship between structural disease and symptoms is not linear. Pain in osteoarthritis is multifactorial and may reflect synovitis, bone-related nociception, muscle weakness, altered biomechanics, psychological factors, and central pain mechanisms in addition to radiographic severity [8]. For this reason, assessment of KOA should incorporate both structural and patient-reported outcomes.

The Knee Injury and Osteoarthritis Outcome Score (KOOS) is a self-administered knee-specific instrument developed to assess pain, symptoms, activities of daily living, sport and recreation, and knee-related quality of life [9]. Higher scores indicate better knee status. In patients with obesity, KOOS domains provide clinically relevant information that is not captured by radiographic grading alone.

Clinical registries offer a practical means of collecting standardized information from patients encountered in routine care. Registry-based research has been used to describe the epidemiology of KOA and to examine associations among patient characteristics, treatments, and outcomes in real-world clinical populations [10]. A structured registry can therefore support simultaneous evaluation of BMI, radiographic severity, and patient-reported outcomes within the same cohort.

The present pilot study used data from an online knee osteoarthritis registry to examine the association between BMI and four clinically relevant outcomes: radiographic severity, pain, physical function, and knee-related quality of life. Because every participant in the available sample met BMI criteria for obesity, the analysis evaluates variation in BMI within an obese KOA cohort rather than comparing obese and non-obese groups.

Materials and Methods

Study design and setting

This was an observational, registry-based pilot study conducted at a physiotherapy centre in Maharashtra, India. Data were obtained from the VIMS Knee Arthritis Registry, an online clinical registry developed to support standardized collection of demographic, clinical, radiographic, and patient-reported information from individuals with KOA.

Participants

Participants were selected by purposive sampling. The study included 20 adults aged 40 years or older who were registered in the knee osteoarthritis registry and had KOA confirmed by clinical assessment and/or imaging. Both unilateral and bilateral knee involvement were eligible. Patients were excluded if they had severe systemic disease considered likely to confound KOA-related outcomes, including cancer or advanced cardiovascular disease, or a history of prior knee surgery such as arthroscopy or total knee replacement.

Ethical considerations and registry procedure

Institutional Ethics Committee approval was obtained before commencement of the study [committee name and approval number should be inserted before submission]. Written informed consent was obtained from all participants. The online registry was developed under the guidance of qualified physiotherapists, with technical implementation by a software engineer according to the clinical data requirements specified by the physiotherapy team. Demographic and clinical data were entered into the registry and stored securely.

Body mass index

BMI was calculated as body weight in kilograms divided by height in metres squared (kg/m²). Participants were classified using conventional World Health Organization BMI categories: class I obesity, 30.0-34.9 kg/m²; class II obesity, 35.0-39.9 kg/m²; and class III obesity, ≥40.0 kg/m² [11].

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Radiographic severity

Radiographic severity was determined from weight-bearing knee radiographs using the Kellgren-Lawrence (KL) grading system [12]. The registry contained KL grades for each participant, and these ordinal grades were used in the correlation analysis.

Patient-reported outcomes

Pain, physical function, and knee-related quality of life were assessed using the KOOS domains recorded in the registry [9]. KOOS scores range from 0 to 100, with 0 representing extreme knee problems and 100 representing no knee problems. The Marathi-translated version available to the investigators was used for Marathi-speaking participants. Permission to use printed copies was obtained through ePROVIDE. Participants completed the questionnaire in print; the researcher scored the forms and entered the resulting domain scores into the registry.

Statistical analysis

Data were exported to Microsoft Excel and analyzed using GraphPad InStat version 3.10. Continuous variables were summarized as mean ± standard deviation (SD) with range, and categorical variables as frequency and percentage. Normality was assessed using the Shapiro-Wilk test. Because the study variables did not satisfy the assumptions for parametric analysis, Spearman rank correlation was used to examine associations between BMI and KL grade, KOOS pain, KOOS physical function, and KOOS quality of life. Correlation coefficients are reported with 95% confidence intervals (CI). A two-sided p value < 0.05 was considered statistically significant. Given the pilot nature of the study and the small sample, all inferential findings were interpreted as exploratory.

Results

Participant characteristics

The study included 20 participants with KOA. Mean age was 74.55 ± 4.19 years (range 64-82 years); 11 participants (55%) were men and 9 (45%) were women. Mean BMI was 32.21 ± 1.57 kg/m² (range 30.44-35.30 kg/m²). Eighteen participants (90%) had class I obesity and two (10%) had class II obesity. No participant had a BMI below 30 kg/m² or ≥40 kg/m². KL grade 2 was present in 8 participants (40%), grade 3 in 6 (30%), and grade 4 in 6 (30%).

Table 1. Participant characteristics (N = 20)

Characteristic	Value
Age, years	74.55 ± 4.19 (range 64-82)
Sex	Male 11 (55%); female 9 (45%)
BMI, kg/m²	32.21 ± 1.57 (range 30.44-35.30)
BMI category	Class I obesity: 18 (90%); class II obesity: 2 (10%)
KL grade	Grade 2: 8 (40%); grade 3: 6 (30%); grade 4: 6 (30%)

KOOS outcomes

Mean KOOS quality-of-life score was 33.75 ± 13.20 (range 6.25-56.25), mean KOOS pain score was 43.54 ± 18.28 (range 8.33-83.33), and mean KOOS physical-function score was 46.20 ± 17.73 (range 13.24-75.00). Lower scores indicate worse knee-related status.

Table 2. KOOS domain scores

KOOS domain	Mean ± SD	Minimum	Maximum
Pain	43.54 ± 18.28	8.33	83.33
Physical function	46.20 ± 17.73	13.24	75.00
Quality of life	33.75 ± 13.20	6.25	56.25

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Association of BMI with radiographic severity and KOOS outcomes

BMI was strongly and positively correlated with KL grade (rho = 0.7731, 95% CI 0.4919 to 0.9083; p < 0.0001), indicating that higher BMI values within this obese cohort were associated with more advanced radiographic grades. BMI was strongly and negatively correlated with KOOS quality-of-life score (rho = -0.8011, 95% CI -0.9203 to -0.5456; p < 0.0001). Moderate negative correlations were observed between BMI and KOOS pain score (rho = -0.4909, 95% CI -0.7726 to -0.0477; p = 0.0280) and between BMI and KOOS physical-function score (rho = -0.4614, 95% CI -0.7568 to -0.0096; p = 0.0406). Because higher KOOS values represent better status, these negative correlations indicate worse pain, function, and knee-related quality of life at higher BMI.

Table 3. Spearman correlations between BMI and study outcomes

Outcome	Spearman rho	95% CI	p value
Kellgren-Lawrence grade	0.7731	0.4919 to 0.9083	<0.0001
KOOS quality of life	-0.8011	-0.9203 to -0.5456	<0.0001
KOOS pain	-0.4909	-0.7726 to -0.0477	0.0280
KOOS physical function	-0.4614	-0.7568 to -0.0096	0.0406

Discussion

This registry-based pilot study found that, among 20 older adults with KOA and obesity, higher BMI was associated with greater radiographic severity and poorer patient-reported outcomes. The strongest relationships were observed for KL grade and KOOS quality of life, whereas associations with KOOS pain and physical function were moderate. These findings should be interpreted in the context of a small, highly selected sample with a narrow BMI range and should not be taken as evidence that BMI independently causes worse KOA outcomes.

BMI and radiographic severity

The positive association between BMI and KL grade is consistent with the established relationship between excess body weight and knee osteoarthritis. Systematic reviews have shown that increasing BMI is associated with greater susceptibility to KOA [2,3]. Mechanical loading is likely to be one component of this relationship; higher body mass increases compressive and other forces transmitted across the knee during daily weight-bearing activity. Obesity may also influence joint tissues through systemic metabolic and inflammatory pathways, making the association more complex than simple load alone [4,5].

The correlation observed in this study (rho = 0.7731) was stronger than might be expected in many heterogeneous clinical cohorts. That magnitude should therefore be interpreted cautiously. Only 20 participants were studied, all had obesity, and BMI values were restricted to 30.44-35.30 kg/m². With such a small and compressed range, individual observations can exert a relatively large influence on a rank-based coefficient. The result is nevertheless directionally consistent with previous work showing a relationship between increasing obesity and the clinical burden of KOA [6,7].

BMI and pain

BMI was moderately associated with lower KOOS pain scores, indicating more severe knee-related pain at higher BMI. This direction is consistent with reports showing greater pain burden at higher levels of obesity [6,7]. However, the relationship was substantially weaker than that observed for radiographic grade or quality of life. This is biologically and clinically plausible because osteoarthritis pain is generated by multiple peripheral and central mechanisms and is influenced by psychological state, sleep, physical activity, comorbidity, and individual pain sensitivity [8]. Radiographic severity and pain therefore do not necessarily progress in parallel.

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BMI and physical function

The moderate inverse relationship between BMI and KOOS physical-function score indicates that greater BMI was associated with more functional difficulty. Higher body mass increases the energy and muscular demands of walking, stair negotiation, transfers, and other weight-bearing activities. In an older population with painful knee disease, these additional demands may compound the effects of reduced muscle strength and mobility. Large observational studies have similarly reported worse physical health and gait-related characteristics in adults with more severe obesity and KOA [6].

BMI and knee-related quality of life

The strongest association in the study was between BMI and KOOS quality of life (rho = -0.8011). Knee-related quality of life is a broader construct than pain intensity alone and reflects the cumulative effect of symptoms, activity restriction, lifestyle adaptation, and awareness of the knee problem. Previous KOOS-based research in people with severe obesity has also demonstrated substantial impairment in pain, activity, sport, and quality-of-life domains [13]. In the present sample, the strong BMI-QOL relationship may therefore reflect the combined burden of pain, mobility limitation, and reduced participation rather than a single physiological pathway.

Clinical implications

The findings support including body-weight assessment in the broader management of patients with KOA, while avoiding weight-based assumptions about an individual patient's pain or function. Experimental and clinical evidence indicates that weight reduction can decrease knee-joint loading and is associated with improvement in symptoms and function among overweight or obese adults with KOA [14,15]. Current clinical guidance strongly recommends weight loss for patients with knee or hip osteoarthritis who are overweight or obese, ideally in conjunction with exercise and other individualized non-pharmacological management [16].

For physiotherapy practice, BMI should therefore be considered alongside pain, muscle performance, joint mobility, activity level, comorbidities, and patient goals. In an older population such as the present cohort, weight management may require coordinated nutritional, medical, and exercise support rather than exercise prescription alone.

Registry-based research

The use of an online registry is a practical strength of the study because it allows clinical, radiographic, anthropometric, and patient-reported data to be stored in a standardized format. Registry-based approaches have proven useful for studying KOA in routine clinical populations [10]. As the VIMS Knee Arthritis Registry expands, a larger dataset could support multivariable analyses, subgroup comparisons, longitudinal follow-up, and more precise estimates of the relationship between BMI and patient outcomes.

Limitations

The sample was small (N = 20), obtained by purposive sampling from a single centre, and should be regarded as exploratory. Every participant met BMI criteria for obesity and 90% had class I obesity; consequently, the study cannot compare obese with non-obese patients, and the restricted BMI range limits generalizability. Cross-sectional observational design precludes causal inference. The analyses were unadjusted, so age, sex, physical activity, pain duration, muscle strength, comorbidities, medication use, and radiographic severity may confound the observed relationships. Multiple correlations were examined without an adjustment for multiplicity, which is reasonable for hypothesis-generating pilot work but increases the possibility of chance findings. Sixth, the source registry description does not specify how an index knee was selected in participants with bilateral disease; this should be clarified in the final submission. Only selected KOOS domains were analyzed, and longitudinal change in BMI or KOOS outcomes was not assessed.

Conclusion

Within this small registry cohort of older adults with KOA and obesity, higher BMI was associated with more advanced radiographic disease and lower KOOS pain, physical-function, and quality-of-life scores. The strongest associations were

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observed for KL grade and knee-related quality of life. These findings are consistent with the broader evidence linking obesity with the structural and clinical burden of KOA, but the restricted BMI range, small sample, and cross-sectional design prevent causal or population-level conclusions. Larger prospective registry studies that include non-obese and more severely obese participants, use standardized index-knee definitions, and adjust for relevant confounders are needed to determine the independent contribution of BMI to KOA outcomes.

Declarations

Ethics approval and consent to participate: Institutional Ethics Committee approval was obtained before study commencement, and written informed consent was obtained from all participants.

Conflict of interest: The authors declare no conflicts of interest related to this study.

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