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Original Research Article

Nutritional status as an independent determinant of structural disease severity and functional disability in female knee osteoarthritis: a comparative cross-sectional study integrating Kellgren-Lawrence grading, WOMAC index and the mini nutritional assessment

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ABSTRACT

Background: Knee osteoarthritis (OA) is a leading cause of chronic pain and disability worldwide, particularly among women, with emerging evidence suggesting that nutritional status may act as a modifiable determinant of disease severity and functional impairment. Objective was to evaluate nutritional status as an independent determinant of structural severity and functional disability in female patients with knee osteoarthritis.

Methods: A cross-sectional study was conducted among 108 female patients aged 45-70 years with knee OA, graded using the Kellgren-Lawrence system. Nutritional status was assessed using the mini nutritional assessment, and functional disability was evaluated using the WOMAC index. Multivariate linear regression analysis was performed to identify independent predictors of functional disability.

Results: Poor nutritional status was significantly associated with higher WOMAC scores and greater radiological severity. A moderate inverse correlation was observed between nutritional status and functional disability ($r=-0.52$, $p<0.001$). Multivariate regression analysis confirmed nutritional status as an independent predictor of functional disability ($\beta=-0.48$, $p<0.001$).

Conclusions: Nutritional status is an independent and clinically significant determinant of both structural severity and functional disability in female knee osteoarthritis. Nutritional optimization may represent a novel, modifiable therapeutic target in the comprehensive management of knee osteoarthritis.

Keywords: Functional disability, Knee osteoarthritis, Malnutrition, Mini nutritional assessment, Nutritional status, Osteoarthritis severity, Quality of life

INTRODUCTION

Knee osteoarthritis (OA) is one of the most prevalent musculoskeletal disorders and a leading cause of disability globally, particularly among aging female populations.^{1,2} It is characterized by progressive cartilage degeneration, joint space narrowing, osteophyte formation, and functional limitation.^{3,4} The burden of knee OA is expected

to increase substantially due to population aging and rising obesity rates.

While traditional risk factors such as age, obesity, and mechanical loading are well established, recent evidence highlights the role of systemic factors, including nutritional status, in influencing disease progression and symptom severity.⁵⁻⁷ Malnutrition- even in individuals with elevated body mass index- has been associated with

reduced muscle strength, increased inflammatory burden, and impaired cartilage repair, all of which may contribute to worsening osteoarthritis outcomes.^{6,9}

Despite growing recognition of the importance of nutritional health, its independent role in determining both structural severity and functional disability in knee osteoarthritis remains insufficiently explored. Therefore, this study aimed to evaluate nutritional status as an independent determinant of disease severity and disability in female patients with knee osteoarthritis.

METHODS

This cross-sectional, time-bound study was conducted among 108 female patients aged 45-70 years with knee osteoarthritis. Participants were recruited from the OPD of the orthopedics department at AIIMS Rishikesh between January 2025 to October 2025 after obtaining informed written consent. Patients with radiographically confirmed knee osteoarthritis (Grade II-III) based on the Kellgren-Lawrence grading system were included in the study, and both unilateral and bilateral cases were considered. Inclusion criteria comprised female patients within the specified age group with clinically and radiologically diagnosed knee osteoarthritis who were able to complete questionnaires independently. Exclusion criteria included inflammatory arthritis, prior lower limb joint replacement, recent intra-articular injections within the past three months, use of assistive devices for ambulation, and severe comorbid conditions affecting mobility. Following enrolment, demographic data, including age, height, weight, and body mass index (BMI), were recorded. Functional disability was assessed using the WOMAC index (validated CRD Pune version), nutritional status was evaluated using the mini nutritional assessment, and radiographic severity was graded using the Kellgren-Lawrence grading system. All participants completed the questionnaires under supervision to ensure completeness and accuracy.

Statistical analysis

Statistical analysis was performed using SPSS version 17.0. Continuous variables were expressed as mean±standard deviation (SD), while categorical variables were presented as frequencies and percentages. The student's t-test and one-way analysis of variance (ANOVA) were used to compare normally distributed continuous variables across groups, and the Chi-square test was applied for comparison of categorical variables. Pearson correlation analysis was performed to assess the relationships between nutritional status (mini nutritional assessment score) and functional disability (WOMAC score), and to examine their associations with age and BMI. Multivariate linear regression analysis was conducted to determine whether nutritional status independently predicted functional disability, with WOMAC score as the dependent variable and MNA score,

age, and BMI as independent variables. A p value <0.05 was considered statistically significant.

RESULTS

A total of 108 female patients were included in the study. The mean age was 52.6±8.4 years, and the mean BMI was 27.2±4.6 kg/m². The majority of patients (55.6%) had KL grade III osteoarthritis. Nutritional assessment revealed that 38.9% had normal nutritional status, 42.6% were at risk of malnutrition, and 18.5% were malnourished.

Table 1: Demographic and clinical characteristics.

Parameters	Value
Age	52.6±8.4
BMI (kg/m²)	27.2±4.6
KL Grade II	48 (44.4%)
KL Grade III	60 (55.6%)

Table 2: Nutritional status distribution and corresponding functional disability (WOMAC scores).

Nutritional status	Frequency	%	WOMAC score mean±SD
Normal	42	38.9	32.4±8.5
At risk	46	42.6	45.7±10.2
Malnourished	20	18.5	58.9±12.4
Total	108	100	-

Table 3: Nutritional status versus KL grade.

Nutritional status	KL grade II	KL grade III
Normal	28	14
At risk	16	30
Malnourished	4	16

Table 4: Pearson correlation analysis of nutritional status, age, and BMI with functional disability (WOMAC score).

Variables	r	P value
MNA	-0.52	<0.001
BMI	0.29	0.01
Age	0.18	0.08

A progressive increase in functional disability was observed across nutritional groups, with WOMAC scores increasing from 32.4±8.5 in the normal group to 58.9±12.4 in the malnourished group. Pearson correlation analysis demonstrated a statistically significant inverse relationship between nutritional status and functional disability ($r=-0.52$, $p<0.001$). Multivariate regression analysis confirmed that nutritional status remained an independent predictor of functional disability after adjusting for age and BMI ($\beta=-0.48$, $p<0.001$).

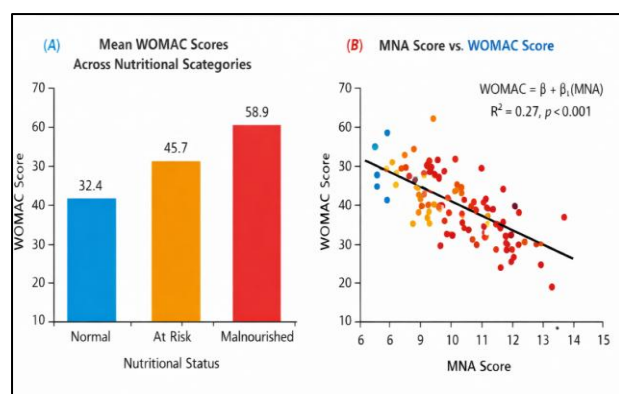


Figure 1: Association between nutritional status and functional disability in females with KOA.

DISCUSSION

The current analysis shows that in female patients with knee osteoarthritis (OA), dietary status is substantially correlated with both radiographic disease severity and functional disability. As nutritional condition deteriorated, WOMAC scores gradually increased, suggesting that patients with decreased nutritional status had more pain, stiffness, and functional limitations. Additionally, despite controlling for age and BMI, nutritional status remained an independent predictor of OA severity, indicating that its impact extends beyond the effects of aging and obesity. These results demonstrate the significance of dietary status as a potentially modifiable factor in the clinical manifestation and course of knee OA.¹¹

The observed association between functional impairment and nutritional status is consistent with earlier research. Among older adults with musculoskeletal problems, malnutrition and the risk of malnutrition were linked to worse physical performance, increased disability, and a lower quality of life. Similarly, data from a systematic analysis showed that poor nutrition is linked to unfavorable clinical outcomes, such as decreased mobility and functional decline, which may make OA-related disability worse.¹² The current study's progressive increase in WOMAC scores across nutritional categories provides further evidence of a dose-response relationship, in which deteriorating nutritional status is associated with increased symptom burden and functional decline.

Several biological factors may explain the association between low nutritional status and the severity of OA. One significant avenue is sarcopenia, which is often linked to malnutrition and is defined by a decrease in skeletal muscle mass and strength.¹³ Reduced muscular strength, especially in the quadriceps, increases the mechanical stress of the articular cartilage by compromising knee joint stability and shock absorption. Muscle weakness has been linked to increased pain, decreased physical function, and a quicker course of knee OA, according to earlier research. Considering the combined impact of joint degradation and

muscle loss, patients with low nutritional health may be more susceptible to functional decline.

Malnutrition may accelerate the development of OA through inflammatory and metabolic processes, as well as by affecting muscle function. Increased oxidative stress and persistent low-grade systemic inflammation, marked by elevated levels of pro-inflammatory cytokines, including interleukin-6 and tumor necrosis factor- α , have been linked to nutritional deficiencies. These mediators of inflammatory responses accelerate structural joint degeneration by promoting extracellular matrix degradation, synovial inflammation, and cartilage degradation. Inadequate consumption of protein, vitamins, and micronutrients can also affect cartilage homeostasis, collagen production, and tissue repair, making it more difficult for joint tissues to adapt to degenerative changes.¹⁴

One noteworthy result of the current study is that even after adjusting for age and BMI, nutritional status remained substantially associated with the severity of OA. Due to increased biomechanical stress and metabolic dysregulation, obesity is widely acknowledged as a major risk factor for knee OA. However, the current data indicate that nutritional health has an additional and independent impact on disease burden. One noteworthy result of the current study is that even after adjusting for age and BMI, nutritional status remained substantially associated with the severity of OA. Due to increased biomechanical stress and metabolic dysregulation, obesity is widely acknowledged as a major risk factor for knee OA.¹⁵ However, the current data indicate that nutritional health has an additional and independent impact on disease burden. The findings of this study have important clinical implications. Nutritional screening using validated tools, such as the mini nutritional assessment (MNA), may help identify patients at risk of more severe disease and poorer functional outcomes early on. Targeted therapies to enhance dietary quality, maximize protein intake, address micronutrient deficiencies, and prevent sarcopenia could be enabled by integrating nutritional evaluation into routine OA management. These therapies may enhance pain management, physical function, and quality of life in addition to traditional pharmaceutical and rehabilitative techniques.^{14,15}

It is important to recognize the limitations of the current investigation. First, it cannot demonstrate a causal association between nutritional status and OA severity due to the cross-sectional design. Second, only female participants comprised the study population, which would limit how broadly the results can be applied to men. Third, nutritional status may not accurately reflect long-term eating patterns or changes in nutrition over time because it was evaluated at a specific point in time. Therefore, to elucidate the temporal relationship between dietary status and OA progression, prospective longitudinal studies are necessary.

Notwithstanding these drawbacks, the study offers significant proof that in female patients with knee OA, dietary status is independently linked to both radiographic severity and functional disability. The observed dose-response relationship between declining nutritional status and rising WOMAC scores highlights the potential significance of nutrition in disease progression and symptom burden. To determine whether changes in nutritional status might reduce disability, slow disease progression, and improve clinical outcomes in individuals with knee OA, future longitudinal and interventional studies are necessary.

The principle that osteoarthritis is a complex condition impacted by systemic health variables is supported by this study. Preventive and therapeutic approaches to the treatment of osteoarthritis may be improved by including dietary evaluation into a biopsychosocial framework.

This study has several limitations. The cross-sectional design limits causal inference. The study population was restricted to females from a single center, which may limit generalizability. Nutritional status was assessed using the mini nutritional assessment rather than biochemical markers. Additionally, reliance on self-reported measures such as the WOMAC Index may introduce reporting bias.

CONCLUSION

Nutritional status is an independent and clinically significant determinant of both structural severity and functional disability in female knee osteoarthritis. Nutritional optimization may represent a novel, modifiable therapeutic target in the comprehensive management of knee osteoarthritis.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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