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Factors influencing pain intensity in knee osteoarthritis: a cross-sectional biopsychosocial perspective

Gökhan Bayrak[1*] and Halil Alkan[1]

Abstract

Background Pain is pivotal in managing knee osteoarthritis (KOA), necessitating tailored rehabilitative strategies. The biopsychosocial framework suggests that a multifaceted approach is crucial for understanding and managing pain in KOA patients. This study explored the factors that influence pain intensity through biological and psychosocial determinants from a biopsychological perspective in KOA patients.

Methods This cross-sectional study included 150 KOA patients with Kellgren-Lawrence (K/L) grades 2–4. Patients were classified into three groups based on their Visual Analogue Scale scores: mild ($n=79$), moderate ($n=40$), and severe pain intensity ($n=31$). The biological determinants included the body mass index, Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) for knee function, the 30-second sit-to-stand (30STS) test for functional strength, and the Timed-Up and Go (TUG) test for mobility. Psychological determinants comprised the Depression Anxiety Stress Scale-21 (DASS-21) for emotional well-being, the Tampa Scale for Kinesiophobia (TSK) for kinesiophobia, and the Activities-Specific Balance Confidence (ABC) scale for balance confidence. Social determinants included educational attainment and the Short Form-36 (SF-36) for health-related quality of life.

Results Significant differences in biopsychosocial determinants were identified among the various pain intensity groups. Biological factors, including WOMAC scores, TUG, and 30STS tests; psychological factors, such as depression and anxiety (DASS-21) and kinesiophobia (TSK); and social factors, including mean years of education and all SF-36 subscales, were significantly worse in the severe pain group ($p<0.05$). However, balance confidence did not differ between groups ($p=0.060$). Patients in the severe pain group exhibited poorer outcomes across biological, psychological, and social domains, whereas the moderate pain group displayed worse biological and social outcomes when compared to the mild pain group ($p<0.05$).

Conclusion This study emphasizes the significance of a biopsychosocial framework in managing pain in KOA patients. Worsened biological factors like knee function, mobility, and functional strength, alongside psychological issues such as depression and anxiety, influence pain intensity. Social determinants, including lower educational attainment and quality of life, highlight the need for patient-centered care. Future research should include diverse populations and longitudinal data to improve interventions and guide global health policies for integrating the biopsychosocial perspective for KOA management.

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Keywords Knee osteoarthritis, Biopsychosocial model, Pain, Physical functional performance, Kinesiophobia, Quality of life

Introduction

Knee osteoarthritis (KOA) stands as a progressive degenerative condition characterized by the gradual deterioration of articular cartilage within the knee joint [1, 2]. The prominent symptoms of KOA are persistent pain, stiffness in the morning, and decreased knee function [3]. A range of factors, including genetic predispositions, obesity, previous injuries, aging, gender differences, specific biomechanical issues in the knee, muscle weakness, job requirements, and hormonal influences, all play a role in its development [1, 2, 4]. Consequently, KOA reduces patients' ability to carry out everyday activities, leading to the investigation of various treatment options, such as medication, physical therapy, and surgery [2, 4]. Comprehensive studies support non-pharmacological treatments, highlighting the importance of lifestyle changes to combat sedentary habits and prevent weight gain, thus reducing the impact of KOA [5, 6].

Pain is the predominant symptom of KOA, attracting considerable focus within the medical field [7]. Jensen et al. categorized pain intensity into mild, moderate, and severe levels, aiding clinicians in tailoring treatment approaches according to patients' reported experiences [8]. However, the subjective nature of pain perception leads to considerable variation among individuals, which complicates both diagnosis and treatment efforts [7]. In the context of KOA, diminished strength in lower extremity muscles, compromised ligaments, joint capsule integrity, and proprioceptive accuracy all contribute to changes in how pain is perceived [9]. Numerous studies have delved into factors linked with knee pain in KOA, identifying age, gender, level of education, and body mass index (BMI) as potential factors [10, 11]. Despite evident degeneration of the knee joint, some individuals experience minimal or negligible pain, prompting questions about the factors that alleviate pain intensity [12].

The biopsychosocial framework, widely accepted since George Engel's proposal in 1977, emphasizes the interconnectedness of biological, psychological, and sociocultural factors in understanding human health [13]. The biopsychosocial framework explains how pain may be amplified by additional emotional and behavioral reactions from the patient's past experiences [14]. Additionally, psychosocial aspects such as depression and stress noticeably impact the experience of pain in KOA and are shown to be good predictors of long-term disability and chronic pain [10, 15, 16]. Current guidelines for biopsychological perspectives regarding physical assessment, decision-making, and personalized care are often overlooked for patient care, highlighting a need for more research on these experiences [17]. A holistic evaluative strategy for KOA should incorporate a biopsychosocial perspective that addresses physical, social, and psychological factors, recognizing that optimal pain management and functional recovery require more than just targeting physiological issues [18]. Therefore, this cross-sectional study aimed to explore the factors from a biopsychological perspective to influence pain intensity through biological and psychosocial assessments in patients with Kellgren-Lawrence (K/L) grades 2–4 KOA.

Materials and methods

This cross-sectional study was conducted at the orthopedics and traumatology outpatient clinic in the Muş State Hospital from November 2021 to November 2023. The sample comprised patients presenting chronic knee pain that had persisted for a minimum of six months attributable to KOA and met specific inclusion and exclusion criteria. Prior to enrolment, participants were informed about the study's objectives, procedures, and potential implications, both verbally and through written documentation. Subsequently, informed consent was obtained from each participant, adhering to the ethical principles of the Declaration of Helsinki. Ethical approval for the study protocol was obtained from the Muş Alparslan University Scientific Research and Publication Ethics Committee (2021–27744/32).

Sample size

Version 3.1.9.4 of the G*Power program (Heinrich-Heine-Universität Düsseldorf, Germany) was used to determine the study sample [19]. The sample size was determined based on the Timed-Up and Go Test (TUG) test score, using comparable studies for reference [20, 21]. To achieve a power rate (β) of 90%, we aimed for a type II error rate of 10% while maintaining a type I error rate (α) of 0.05. The effect size (d) parameter was set at 0.3, which resulted in a minimum requirement of 144 patients to complete the study.

Eligibility criteria

The diagnosis of KOA and K/L grades were established by a specialized orthopedist with at least 5 years of experience through radiographic X-ray assessment, incorporating patients' reported pain symptoms and observed alterations in knee function. Inclusion criteria encompassed adults aged 40 years and above, presenting persistent knee pain lasting at least six months, activity-induced knee joint discomfort, and morning stiffness, alongside radiographic evidence of K/L grades 2, 3, or 4.

Exclusion criteria comprised any muscular or neurological conditions impacting lower extremity function, history of corticosteroids, hyaluronic acid or platelet-rich plasma injections in the last year, severe cardiac or renal comorbidities, significant autoimmune, psychiatric, systemic, or inflammatory diseases, and history of unilateral or unicondylar knee arthroplasty. Between 2021 and 2023, a total of 179 patients were admitted to the orthopedics and traumatology outpatient clinic at Muş State Hospital. Sixteen patients were excluded from the study due to receiving injections in the affected knee last year. Additionally, three patients were excluded from using walking assistance, two due to severe renal comorbidities, and another two could not understand the local language. Six patients chose not to participate in the study, as illustrated in the flowchart (Fig. 1).

Procedure

Participants who met predefined study inclusion criteria underwent comprehensive assessments, including outcome measures to assess the patient's biological, psychological, and social determinants. The study also documented the sociodemographic and clinical characteristics of the patients, including age, gender, affected extremity, K/L grades of KOA, chronic diseases, number of drugs used, history of previous surgery, number of falls in last year, type of toilet utilized, Charlson comorbidity score, and Visual Analogue Scale (VAS) pain levels. Subsequently, patients were categorized into distinct pain intensity groups—mild (5 to 44 mm, $n = 79$), moderate (45 to 74 mm, $n = 40$), and severe (75 to 100 mm, $n = 31$)—based on their self-reported levels of knee pain intensity utilizing the VAS average pain over the last week [8].

Outcomes

Biological determinants

The patient's height and weight were measured at the clinic. BMI was calculated by weight in kilograms divided by height (cm) in square meters [22].

Knee function was evaluated through the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), which comprises 24 questions scoring from 0 (indicating absence) to 4 (indicating severe symptoms). The WOMAC has three dimensions: physical function (17 questions), pain (5 questions), and stiffness (2 questions). WOMAC total score is a sum of pain, stiffness, and disability scores and ranges from 0 to 96, with higher scores indicating poorer functional status [23].

Physical performance was quantified via the 30-second sit-to-stand test (30STS) and the TUG test. The 30STS test indicates functional lower extremity strength and involves repetitive cycles of standing up and sitting down within a 30-second timeframe [24]. The TUG test measures the patients' mobility with the time taken to rise from a chair, walk a designated three-meter distance, return, and sit back down [25].

Psychological determinants

The emotional condition of participants was evaluated with the Depression Anxiety Stress Scale-21 (DASS-21), featuring 21 self-reported questions rated on a 4-point scale. Scores for depression, anxiety, and stress were derived from subscales formed by collecting related questions [26].

The Tampa Scale for Kinesiophobia (TSK), consisting of 17 items rated on a 4-point Likert scale, was utilized to measure the fear of movement or re-injury, with scores ranging from 17 to 68. A higher score implies a greater degree of kinesiophobia, with 37 or more indicating a high level [27].

Balance confidence was evaluated using the Activities-Specific Balance Confidence (ABC) scale, a 16-item self-assessment tool measuring individuals' confidence in engaging in various activities, with scores ranging from 0 to 100%. A score below 50% indicates a low level of functioning and is associated with balance impairment; between 50 and 80% suggests a moderate level of functioning, while scores above 80% signify a high level of functioning [28].

Social determinants

Patients' educational levels were evaluated by questioning participants about their highest educational years.

Health-related quality of life was assessed using the Short Form-36 (SF-36), a generic self-assessment tool comprising 36 items. SF-36 consists of eight dimensions under the sub-headings of physical function, social function, role limitations due to physical problems, role limitations due to emotional problems, mental health, energy/vitality, pain, and general health perception, each scaled from 0 to 100. Higher scores indicate better health perception across various domains [29].

Statistical analysis

Statistical analyses were conducted using IBM® SPSS© 25 software. The normality of numerical variables was assessed visually (histogram and probability graphs) and analytically (Kolmogorov-Smirnov), with descriptive statistics presented as means and standard deviations for normally distributed variables and numbers and percentages for categorical variables. One-way analysis of variance (ANOVA) was utilized to compare groups with a normal distribution, while the Pearson Chi-square test was employed for categorical variables. Statistical significance was established at $p < 0.05$.

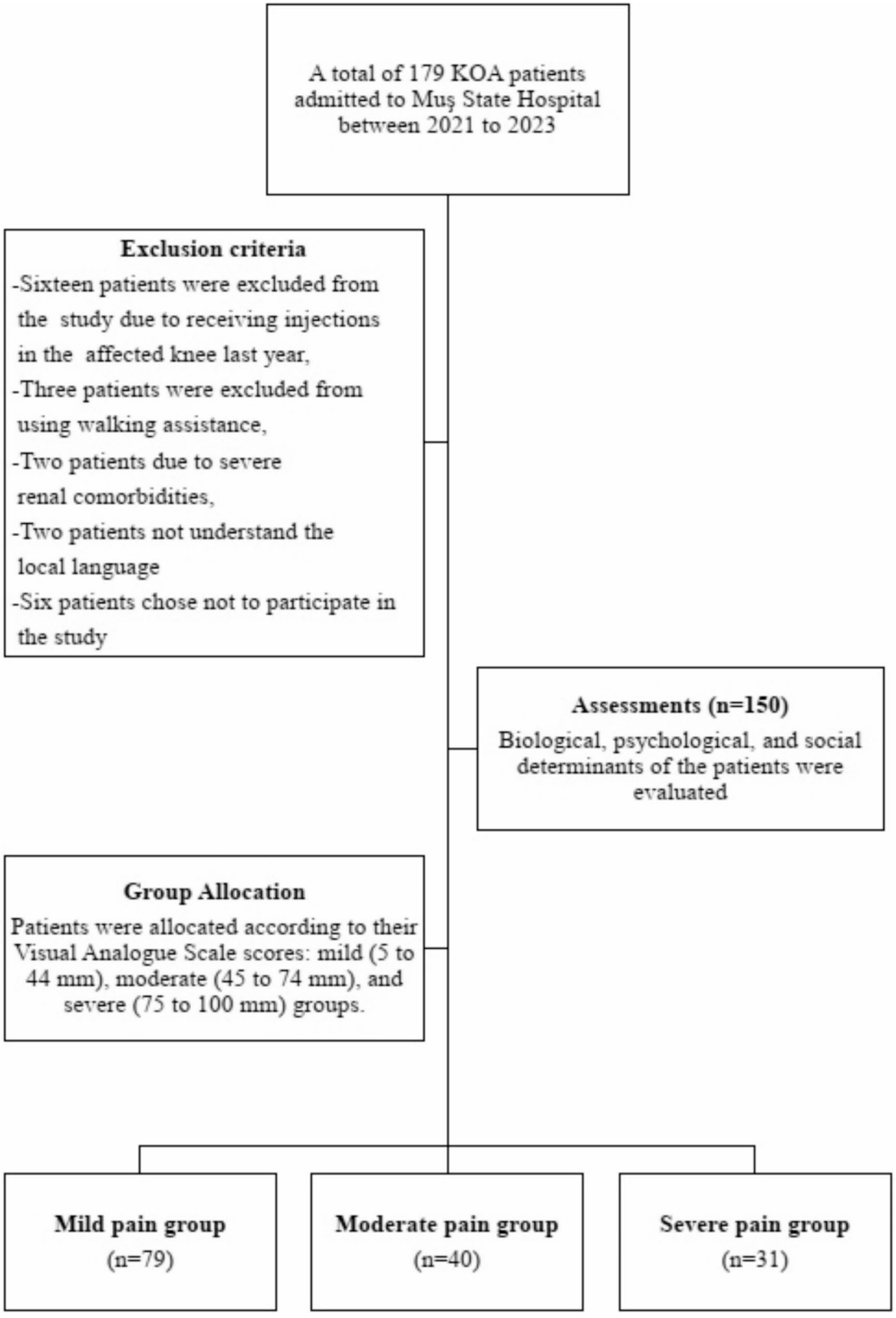

Fig. 1 Flow chart of the study

Results

Most patients, comprising 81.3%, were identified as female, with a significant portion, totaling 79.3%, being homemakers. Most patients use floor toilets, which account for 80.7% of the total. Among the patients, 52.7% reported the nondominant extremity as the affected side, while 46.7% were categorized under K/L stage 3 KOA. All patients diagnosed with K/L stages 2 to 4 KOA exhibited an average age of 59.79 ± 9.01 years. The mean BMI was measured at 31.81 ± 9.21, while the mean VAS pain intensity was recorded as 4.36 ± 2.75. Table 1 provides detailed data outlining the KOA patient's sociodemographic and clinical characteristics.

After comparing the groups based on pain intensity, notable differences were observed between the mild and severe KOA cohorts in several demographic and clinical parameters. Statistically significant disparities were noted in mild and severe pain groups in gender ($p = 0.003$), occupation ($p = 0.011$), and K/L stage of KOA ($p = 0.006$). However, no significant distinctions were found between the groups concerning type of toilet usage ($p = 0.186$) and affected extremity ($p = 0.410$), as outlined in Table 2.

Notable statistical differences were identified across various domains after comparing the biopsychosocial determinants among the groups based on pain intensity. Specifically, significant variations were observed in biological metrics, including the WOMAC physical function ($p = 0.001$, $F = 20.22$), stiffness ($p = 0.001$, $F = 25.82$), pain ($p = 0.001$, $F = 51.29$), and total scores ($p = 0.001$, $F = 38.83$), TUG test ($p = 0.001$, $F = 7.91$) and the 30STS test ($p = 0.001$, $F = 9.95$). However, BMI did not differ between groups ($p = 0.109$, $F = 2.25$). Differences were noted in the psychological determinants on DASS-21 depression ($p = 0.023$, $F = 3.86$) and anxiety ($p = 0.001$, $F = 11.05$) subscales, as well as in TSK kinesiophobia levels ($p = 0.001$, $F = 5.82$). However, no significant difference was observed between the groups in the ABC balance confidence score ($p = 0.060$, $F = 2.86$). Social determinants, including mean years of education ($p = 0.024$, $F = 3.83$) and all sub-scales of the SF-36 questionnaire ($p < 0.05$, $3.06 \leq F \leq 18.35$), differed between groups. However, no significant distinctions were observed between the groups in number of chronic diseases ($p = 0.656$, $F = 0.42$), number of previous surgery ($p = 0.442$, $F = 0.82$), number of falls in the last year ($p = 0.062$, $F = 2.83$), and Charlson comorbidity index ($p = 0.353$, $F = 1.05$). Further pairwise comparisons following post-hoc testing revealed that the observed statistical differences in

Table 1 The sociodemographic and clinical characteristics of the patients

		All patients ($n = 150$)	
		n	**(%)**
Sociodemographic characteristics			
Gender	Female	122	81.3
	Male	28	18.7
Occupation	Retired	18	12.0
	Homemaker	119	79.3
	Farmer	9	6.0
	Worker	4	2.7
Type of toilet used	Floor toilet	121	80.7
	Closet	29	19.3
Osteoarthritis stage (K/L)	Stage 2	51	34.0
	Stage 3	70	46.7
	Stage 4	29	19.3
Affected extremity	Dominant	71	47.3
	Nondominant	79	52.7
		Mean	**SD**
Clinical characteristics			
Age (year)		59.79	9.01
Height (cm)		1.63	0.12
Weight (kg)		83.09	11.71
BMI (kg/m^2)		31.81	9.21
VAS score		4.36	2.75
Number of chronic diseases		0.96	0.93
Charlson Comorbidity Index score		0.33	0.59
Number of drugs used		1.08	1.27
Number of previous surgeries		1.20	1.14
Number of falls in last year		0.41	0.87

VAS; Visual Analogue Scale, BMI; Body mass index, SD; Standard Deviation, K/L: Kellgren-Lawrence

Table 2 The categorical factors associated with the intensity of pain in patients with KOA

		VAS pain intensity						*P*
		Mild [a] (*n* = 79)		Moderate [b] (*n* = 40)		Severe [c] (*n* = 31)		
		n	%	*n*	%	*n*	%	
Gender	Female	57	72.2	34	85.0	31	100.0	**0.003*[a–c]**
	Male	22	27.8	6	15.0	0	0.0	
Occupation	Retired	16	20.3	2	5.0	0	0.0	**0.011*[a–c]**
	Homemaker	55	69.6	34	85.0	30	96.8	
	Farmer	5	6.3	4	10.0	0	0.0	
	Worker	3	3.8	0	0.0	1	3.2	
Type of toilet used	Floor toilet	60	75.9	36	90.0	25	80.6	0.186
	Closet	19	24.1	4	10.0	6	19.4	
Kellgren-Lawrence Osteoarthritis stage	Stage 2	34	43.0	9	22.5	8	25.8	**0.006*[a–c]**
	Stage 3	36	45.6	23	57.5	11	35.5	
	Stage 4	9	11.4	8	20.0	12	38.7	
Affected extremity	Dominant	35	44.3	18	45	18	58.1	0.410
	Nondominant	44	55.7	22	55	13	41.9	

Pearson Chi-square test. *: Statistical difference between groups, VAS: Visual Analogue Scale

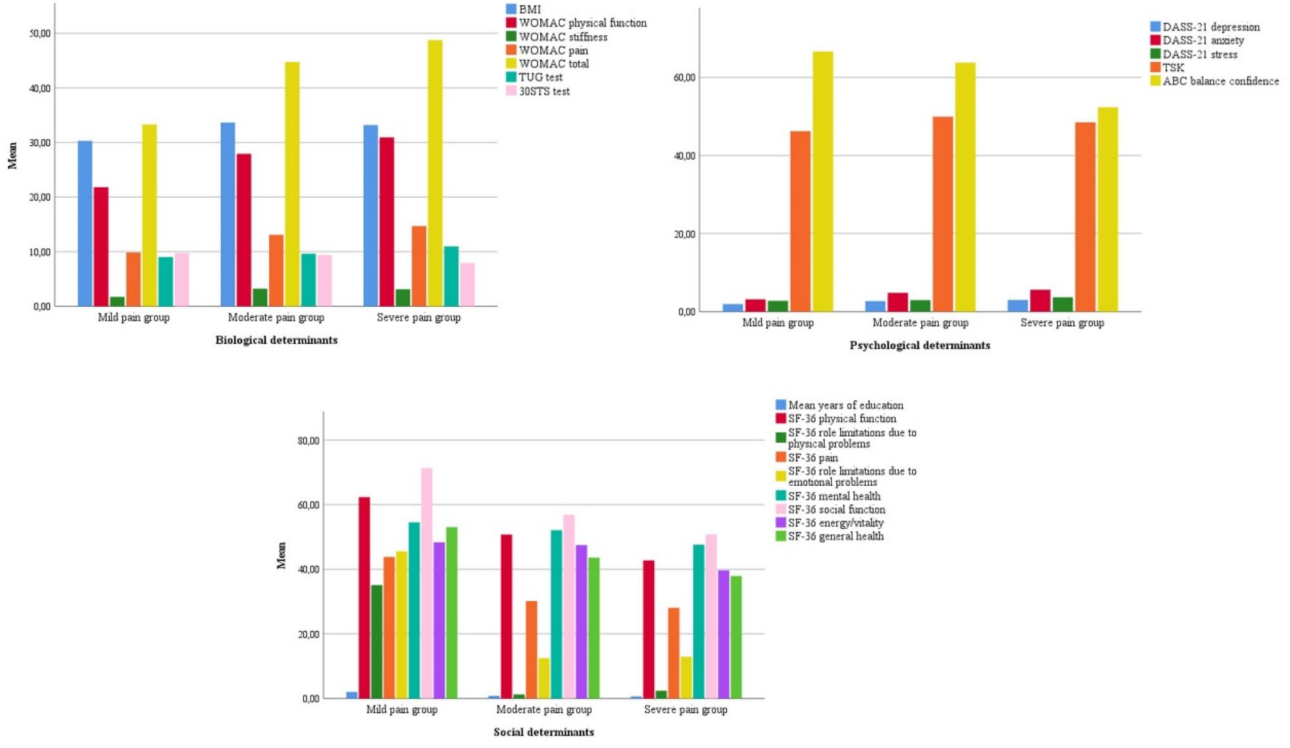

Fig. 2 Comparison of mean biopsychosocial determinant scores of the groups

biological (WOMAC, TUG test, and 30STS test), psychological (DASS-21 depression and anxiety), and social (mean years of education and SF-36) determinants were primarily driven by the severe pain group. Moreover, the moderate pain group exhibited inferior outcomes in the biological (WOMAC-pain subscale, TUG test, 30STS) and social (SF-36 physical function subscale) compared to the mild pain group, as depicted in Fig. 2. However, no significant distinctions were observed between the groups in the clinical determinants such as the presence of chronic disease ($p = 0.656$), history of surgery ($p = 0.442$), the number of falls in the last year ($p = 0.062$), and Charlson comorbidity index ($p = 0.353$) (Table 3).

Discussion

The findings of this study underscore the multifaceted nature of KOA pain intensity through a biopsychosocial perspective. Biologically, significant impairments in

Table 3 Comparison of the biopsychosocial and clinical determinants in mild, moderate, and severe pain intensity groups

		VAS pain intensity						F	*P*	Post-Hoc
		Mild [a] (*n* = 79)		Moderate [b] (*n* = 40)		Severe [c] (*n* = 31)				
		Mean ± SD	95% CI	Mean ± SD	95% CI	Mean ± SD	95% CI			
Biological determinants	**BMI (kg/m^2)**	30.31 ± 3.98	29.42–31.21	33.67 ± 16.57	28.37–38.97	33.20 ± 3.26	32-34.39	2.25	0.109	-
	WOMAC									
	Physical function	21.82 ± 8.46	19.93–23.72	27.93 ± 6.11	25.97–29.88	30.94 ± 5.80	30.94–33.06	20.22	**0.001***	a-b, a-c
	Stiffness	1.73 ± 1.26	1.45–2.02	3.23 ± 1.14	2.86–3.59	3.13 ± 1.28	2.66–3.60	25.82	**0.001***	a-b, a-c
	Pain	9.86 ± 2.36	9.33–10.39	13.10 ± 3.04	12.13–14.07	14.71 ± 1.83	14.04–15.38	51.29	**0.001***	a-b, b-c, a-c
	Total	33.30 ± 10.73	30.90-35.71	44.75 ± 7.44	42.37–47.13	48.77 ± 7.59	45.99–51.56	38.83	**0.001***	a-b, a-c
	TUG test (second)	9.02 ± 1.95	8.59–9.46	9.64 ± 2.47	8.85–10.43	10.97 ± 2.89	9.91–12.03	7.91	**0.001***	a-c, b-c
	30STS test (repeat)	9.77 ± 2.18	9.28–10.26	9.40 ± 1.61	8.88–9.92	7.94 ± 1.69	7.31–8.56	9.95	**0.001***	a-c, b-c
Psychological determinants	**DASS-21**									
	Depression	1.95 ± 1.75	1.56–2.34	2.70 ± 2.36	1.95–3.45	3.00 ± 2.07	2.24–3.76	3.86	**0.023***	a-c
	Anxiety	3.15 ± 2.29	2.64–3.66	4.80 ± 3.08	3.81–5.79	5.61 ± 3.14	4.46–6.76	11.05	**0.001***	a-b, a-c
	Stress	2.78 ± 2.23	2.29–3.28	2.95 ± 2.45	2.17–3.73	3.68 ± 2.65	2.71–4.65	1.58	0.208	-
	TSK	46.23 ± 5.75	44.94–47.52	49.95 ± 5.10	48.32–51.58	48.48 ± 6.74	46.01–50.96	5.82	**0.004***	a-b
	ABC scale	66.65 ± 29.00	60.15–73.14	63.78 ± 27.94	54.84–72.71	52.36 ± 26.88	42.50-62.22	2.86	0.060	-
Social determinants	**Mean years of education**	2.01 ± 3.50	1.23–2.80	0.80 ± 1.90	0.19–1.41	0.65 ± 1.70	0.3–1.27	3.83	**0.024***	a-c
	SF-36									
	Physical functioning	62.34 ± 20.22	57.81–66.87	50.75 ± 16.93	45.34–56.16	42.74 ± 14.07	37.58–47.90	14.44	**0.001***	a-b, b-c
	Role limitations due to physical problems	35.12 ± 46.08	24.80-45.44	1.25 ± 7.91	0-3.77	2.42 ± 13.47	0-7.36	17.64	**0.001***	a-b, a-c
	Pain	43.82 ± 16.98	40.02–47.63	30.19 ± 11.99	26.35–34.02	28.06 ± 11.54	23.83–32.30	18.35	**0.001***	a-b, a-c
	Role limitations due to emotional problems	45.57 ± 50.12	34.34–56.80	12.50 ± 33.49	1.79–23.21	12.90 ± 34.08	0.40–25.40	10.83	**0.001***	a-b, a-c
	Mental Health	54.53 ± 14.15	51.36–57.70	52.10 ± 11.08	48.56–55.64	47.61 ± 13.36	42.71–52.51	3.06	**0.048***	a-c
	Social Function	71.36 ± 25.96	65.55–77.17	56.88 ± 21.73	49.92–63.83	50.81 ± 22.35	42.61-59	9.93	**0.000***	a-b, a-c
	Vitality	48.35 ± 14.84	45.03–51.68	47.50 ± 14.50	42.86–52.14	39.68 ± 10.40	35.86–43.49	4.49	**0.013***	a-c
	General health	53.04 ± 20.25	48.50-57.57	43.63 ± 16.91	38.22–49.03	37.90 ± 19.53	30.74–45.07	7.91	**0.001***	a-b, a-c
Clinical characteristics	Number of chronic diseases	0.92 ± 0.89	0.73–1.12	0.92 ± 0.83	0.66–1.19	1.10 ± 1.14	0.68–1.51	0.42	0.656	-
	Number of previous surgeries	1.09 ± 1.06	0.85–1.33	1.30 ± 1.07	0.96–1.64	1.35 ± 1.38	0.85–1.86	0.82	0.442	-
	Number of falls in last year	0.39 ± 0.77	0.22–0.57	0.23 ± 0.58	0.04–0.41	0.71 ± 1.27	0.24–1.18	2.83	0.062	-
	Charlson Comorbidity Index	0.31 ± 0.56	0.19–0.44	0.25 ± 0.44	0.11–0.39	0.45 ± 0.81	0.16–0.75	1.05	0.353	-

ANOVA Test, *: Statistical difference between groups. SD: Standard Deviation; 95% CI: 95% Confidence Intervals for means; VAS: Visual Analogue Scale; BMI: Body mass index; WOMAC: Western Ontario and McMaster Universities Arthritis Index; TUG: Time up and go; 30STS: 30-second sit-to-stand; DASS-21: Depression Anxiety Stress Scale-21; TSK: Tampa Scale for Kinesiophobia; ABC: Activities-specific Balance Confidence; SF-36: Short Form-36

physical function, lower extremity strength, and mobility (WOMAC, TUG, and 30STS) emphasize the roles of functional limitations in pain intensity. Psychologically, elevated depression, anxiety, and kinesiophobia in severe pain group highlight the emotional and cognitive burdens that may worsen disability. Socially, educational attainment and SF-36 subscale scores among individuals with severe pain indicate a decrease in quality of life and social functioning. Biological, psychological, and social determinants highlight the complex interplay and support the need for multidisciplinary KOA management.

Pain emerges as an important clinical complaint experienced by individuals with KOA, compelling them to get medical care [30]. Since knee pain is a complex health condition best understood through a biopsychosocial framework, the predominant medical interventions limit comprehensive treatment and neglect the influence of individual reflections and social factors [18]. Moreover, heightened knee pain levels, alongside the expression of bilateral knee symptoms, emerge as predictive indicators for exacerbated pain intensity [31]. A recent study has elucidated a noteworthy correlation between elevated knee function scores and the tendency for heightened pain intensity among KOA patients [10]. Furthermore, earlier findings indicated a positive correlation between pain intensity and declined knee function [32]. Care within the biopsychosocial framework involves understanding pain's multidimensional impact and influence on various biopsychosocial domains [17]. This study confirms earlier findings, affirming the interplay between diminished knee function and heightened pain levels among KOA patients experiencing severe pain intensity. In line with existing literature, our research underscores the connection between self-reported diminished knee function and the severity of knee pain from a biological perspective. Potentially, this outcome may be attributed to the degenerative nature of KOA, wherein diminished knee function tends to coincide with severe pain intensity. For managing KOA pain, it's essential to combine prompt pharmacotherapy with patient education on weight loss, work modifications, and home environmental adjustments to reduce strain while also addressing psychological and social factors that may restrain the progress of KOA. Clinicians should thus be cognizant of this dynamic when formulating rehabilitative strategies for KOA patients.

There is limited literature exploring the association between physical performance and pain intensity among patients suffering from KOA. A prior meta-analysis concluded that lower walking speed was a prognostic factor for the decline in performance-based outcomes [31]. McAlindon et al. posited that the TUG and 30STS tests are recommended as optimal evaluative tools for assessing physical performance in KOA patients [33]. Notably, heightened performance duration in the TUG test (11.1 s), indicative of impaired mobility, correlates with heightened pain severity among KOA patients [34]. An earlier study revealed that in assessing physical performance from biopsychosocial respect, the authors indicate that patients with knee pain show varying levels of physical performance, which is closely related to how much pain they experience during everyday activities [35]. In our investigation, patients in the severe pain intensity group exhibited the worst performance on 10.97 s of TUG test durations similar to those reported by Lowry et al. [34] and Cruz-Almeida et al.'s biopsychosocial conclusions for physical performance [35]. However, in the 30STS test, only the mild pain intensity group achieved a noteworthy number of repeats (9.77), contrasting with Lowry et al.'s findings (9.7 repeats). Remarkably, our severe pain intensity group displayed the poorest performance (7.40 repeats) in the 30STS performance from a biological perspective relative to their mild and moderate pain groups. These findings indicate a strong association between physical performance and the high pain intensity experienced by patients with KOA. Since pain is linked to joint pathology in a complex manner [36], it is reasonable to interpret the results of this study's TUG and 30STS test findings in this context. Notably, the severe pain intensity group primarily consisted of patients with K/L grade 4 KOA; in contrast to those in the mild and moderate pain intensity groups, the observed physical performance could be reasonable from a biological perspective.

Recent research has unveiled a close association between anxiety, depression, and movement, thereby impacting the intensity of knee pain in women [37] and the general population suffering from KOA [32, 38]. Overton et al. indicated that psychological factors are significantly related to the experience of knee pain. The authors suggest that the interplay between knee pain, depression, distress, and anxiety may create a reciprocal relationship, perpetuating a damaging cycle that exacerbates the overall pain experience [39]. Several studies have identified that psychological determinants, such as greater depression and anxiety, are significant and exacerbating factors for worsened knee pain and disability [10, 26, 40, 41]. In cases where chronic knee pain is not effectively managed, anxiety and depression may intensify the pain experienced by patients with KOA [16, 42]. Consistent with previous research, our study established that elevated levels of psychological determinants, including depression and anxiety, were present in patients with severe pain intensity, which suggests that psychological support may be necessary for patients with heightened knee pain. These findings highlight the impact of depression and anxiety on pain intensity and

emphasize their importance in designing rehabilitative approaches that consider psychological well-being.

Kinesiophobia, defined as a psychological aversion to movement or functional activities due to fear of exacerbating pain [37, 43], is often considered a coping mechanism employed to alleviate heightened knee pain [38]. This psychological factor has been shown to significantly impact pain levels and physical function deterioration in KOA patients [16]. A five-year longitudinal study demonstrated the predictive role of kinesiophobia in the progression of KOA and established it as a strong indicator of symptom severity [10]. This aligns with prior research demonstrating a robust correlation between kinesiophobia and pain intensity [37, 38, 43]. Our study supports previous findings, demonstrating that increased levels of kinesiophobia are significantly associated with heightened pain levels, particularly within the moderate pain group compared to the mild pain group. This finding highlights the psychological impact of kinesiophobia on pain perception and severity, suggesting that cognitive and emotional factors play a crucial role in the experience of knee pain among individuals with KOA. The implications of these results emphasize the necessity for integrating psychological assessments and interventions in the management of pain for KOA patients.

Balance confidence refers to an individual's belief in their ability to maintain stability while performing various movements [44]. Lajoie and Gallagher (2004) conducted a detailed analysis of the ABC scale, establishing a cut-off score of 67% or higher [45]. Bobić Lucić and Grazio (2018) discovered that patients with KOA demonstrated significantly lower balance confidence, with an average score of only 57.8% [46]. Cruz-Almeida et al. categorized KOA patients based on their level of movement-evoked pain: minimal, moderate, and severe. They discovered that those in the severe pain group had significantly lower balance scores [35]. John et al. highlighted that low levels of balance confidence, along with factors such as pain, history of falls, and physical function, raise significant concerns for KOA patients in rehabilitation settings regarding their balance confidence scores [44]. Our study's assessment of balance confidence indicated that moderate functional levels yielded similar but lower scores across mild (66.65), moderate (63.78), and severe pain (52.36) groups, exhibiting no discernible differences. Additionally, a similar incidence of falls among the groups over the past year may serve as an indicative marker, further supporting the similar balance confidence scores observed. These findings raise the possibility that the balance confidence may encompass the patient's subjective perception of balance confidence during daily activities and the potential psychological factors, including anxiety and depression, which are possibly influenced by heightened kinesiophobia and diminished physical performance in all groups.

The World Health Organization defines quality of life as an individual's perception of their role within the cultural context, which includes their aspirations, expectations, norms, and concerns [47]. The Osteoarthritis Research Society International (OARSI) has recommended assessing the clinical outcomes related to health-related quality of life in patients with KOA, emphasizing the importance of social determinants [33]. Chronic pain significantly influences the quality of life across diverse aspects [48]. Numerous studies have demonstrated a negative correlation between lower quality of life scores and heightened pain severity [49, 50], with chronic pain in KOA patients triggering a decline in quality of life [30, 36, 37, 39]. Zeng et al. have highlighted that KOA patients experiencing pain exhibit reluctance to engage in knee movements, consequently diminishing their quality of life over time [2]. Consistent with existing literature, our study reveals that patients in the mild pain group exhibit better quality of life scores compared to those in the moderate and severe pain intensity groups. These findings suggest that KOA patients suffering from severe pain experience a significantly lower quality of life along with higher levels of anxiety and depression. The outcomes related to quality of life highlight the importance of incorporating social considerations into research and policy in patients with severe pain. By doing so, researchers can develop more comprehensive strategies to promote positive social change and improve population health.

A low level of education has been identified as a significant prognostic indicator for pain in KOA patients, as evidenced by previous studies [34, 37]. In their investigation, Kaushal et al. included participants possessing the lowest level of high school education and observed a correlation between lower educational attainment and increased severity of KOA symptoms [22]. This finding suggests that educational background may be linked to the intensity of symptoms experienced by patients. Contrarily, Cruz Almeida et al. reported that patients across mild, moderate, and severe movement-evoked pain groups possessed a minimum educational level of high school or less, revealing no discernible differences in educational attainment among these cohorts [35]. This study elucidates that lower educational attainment is associated with heightened pain severity in KOA patients. However, our study sample displayed a considerably lower educational background than prior investigations. Still, the findings of the educational level, which is one of the social determinants of pain-related symptoms, align with most previous studies [12, 34, 37].

Several previous reports have identified female gender as a risk factor for pain in KOA [14, 31, 37, 38]. Our study further supports these findings, showing a correlation

between female gender and increased pain severity in patients with KOA. However, clinical determinants such as the number of chronic diseases, previous surgeries, falls in the last year, and Charlson score did not exhibit any significant association with pain intensity.

Non-surgical approaches in KOA management include first-line pharmacologic therapy, physical therapy, joint protection strategies, weight reduction, environmental modifications, intra-articular injections, and exercise training [14, 48]. Comprehensive international studies predominantly focus on biological factors, such as radiographic imaging and biomarkers, rather than psychosocial factors [14, 16, 48]. However, incorporating biopsychosocial approaches and educational strategies that address improved pain-related factors—such as functional status, kinesiophobia, depression, anxiety, balance confidence, and physical performance—could be beneficial for managing heightened pain intensity in long-term follow-ups for patients with KOA. From a biopsychosocial perspective, patients with KOA who are present with severe pain should be assessed through the view of biological, psychological, and social determinants. The presence of comorbidities should also be carefully evaluated in relation to pain intensity, as comorbid conditions may require a differentiated approach to personalized treatment strategies. These patients should receive increased attention and intervention from physiotherapists and healthcare providers to address the multifaceted nature of their condition.

This study exhibits several strengths. Firstly, it thoroughly explores the factors associated with pain intensity across distinct categories: mild, moderate, and severe. It also addresses a gap in existing literature by investigating the relationship between balance confidence and pain across these pain intensity groups. Furthermore, this study offers a comprehensive exploration of factors associated with pain intensity in KOA patients from a biopsychosocial perspective, utilizing biopsychosocial, sociodemographic, and clinical outcome measures.

This study is subject to several limitations. Firstly, the patient's physical activity level was not assessed, which could be linked to pain intensity. Another limitation of the study is that the sample comes from a specific geographic region, which may not represent the broader KOA population and could limit the generalizability of the findings. Lastly, the patient's prior treatment history was not evaluated.

Conclusion

This study indicates that biopsychological factors significantly influence pain intensity in KOA, with diminished knee function, mobility, and functional lower extremity strength contributing to increased pain severity, while psychological factors such as depression, anxiety, and kinesiophobia further intensify symptoms. Adopting a biopsychosocial framework for managing pain intensity in KOA patients, integrating biological, psychological, and social determinants into clinical and rehabilitative strategies utilizing patient-centered care models are required. Policymakers and healthcare providers should prioritize multidisciplinary approaches that combine pharmacological treatments with tailored physiotherapy, psychological interventions, and education on lifestyle modifications. Future research should expand to diverse and multicentered populations and incorporate longitudinal assessments to refine biopsychosocial interventions and inform global health policies addressing KOA.

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Visualization, conception and design: GB, HA. Data acquisition: GB. Statistical analysis: HA. Writing–review & editing and final approval of the manuscript: GB, HA. Manuscript formatting and submission: GB.

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Data availability
The datasets generated during and/or analyzed during the current study are not publicly available but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This study was conducted adhering to the Declaration of Helsinki. Muş Alparslan University Scientific Research and Publication Ethics Committee approved the study (2021–27744/32). The written informed consent form was obtained from all patients before participating in the study.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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