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Original Article

The Relationship Between Body Awareness and Pain Severity, Static Balance, and Functional Performance in Female Patients with Knee Osteoarthritis: A Cross-Sectional Study

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What is already known on this topic?

- *Body awareness–based and mind–body approaches have been shown to improve pain and function in various chronic musculoskeletal conditions, including osteoarthritis.*
- *Pain, impaired balance, and reduced functional performance are common clinical problems in patients with knee osteoarthritis.*

What this study adds on this topic?

- *Body awareness is negatively associated with pain severity and anteroposterior postural sway in women with knee osteoarthritis.*
- *These associations are attenuated after adjustment for age, body mass index, and disease duration, highlighting the role of clinical covariates.*

ABSTRACT

Objectives: To examine the associations between body awareness (BA) and pain, static balance, and functional performance in women with knee osteoarthritis (OA).

Methods: This cross-sectional study included 24 women with moderate unilateral knee osteoarthritis (mean age 55.5 ± 7.5 years; body mass index (BMI) 29.9 ± 4.9 kg/m^2). Body awareness (Body Awareness Questionnaire, BAQ), pain during activity (visual analogue scale, VAS), static balance (anteroposterior/mediolateral postural sway during eyes-open and eyes-closed stance using a force plate), and functional performance (Timed Up & Go, TUG) were assessed. Spearman correlations were calculated. Hierarchical multiple regression tested whether BAQ independently predicted pain and anteroposterior (AP) sway after adjusting for age, BMI, and disease duration.

Results: Body Awareness Questionnaire was negatively correlated with disease duration ($r = -0.680$, $P < .001$), VAS ($r = -0.557$, $P < .005$), and eyes-closed AP sway ($r = -0.738$, $P < .001$), and moderately correlated with eyes-open AP sway ($r = -0.456$, $P = .025$). Body Awareness Questionnaire was not associated with mediolateral sway or TUG ($P > .05$). In adjusted regression models, BAQ was not a statistically significant independent predictor of pain or AP sway (all $P > .05$).

Conclusion: Higher BA was associated with lower pain and reduced AP sway in bivariate analyses, but these relationships attenuated after accounting for age, BMI, and disease duration. Longitudinal studies with larger samples and more sensitive functional measures are warranted.

Keywords: Body awareness, functional performance, knee osteoarthritis, pain, static balance

Introduction

Knee osteoarthritis (OA) is one of the most prevalent musculoskeletal disorders and can impair patients' physical, social, emotional, and functional well-being.[1] Physical activity and exercise are emphasized as the first-line management strategies, and aerobic and strengthening programs that support strong evidence were found to be effective interventions in the management of knee OA.[2]

In contrast, patients with knee OA prevalently tend to be sedentary or at an inadequate level of physical activity because of the chronic and limiting knee pain and subsequently developed fear of movement.[3] Given the tendency toward sedentary lifestyles in individuals with knee OA—contributing to greater disability and increased healthcare costs—research has increasingly focused on preventive strategies and multidimensional interventions within a biopsychosocial framework.[4]

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The concept of body awareness (BA) has become more popular as a part of the biopsychosocial model for patients with chronic pain in the last decades.[5-7] The definition of BA is the ability to focus attention and be aware of interior bodily sensations, such as proprioception and interoception.[8] When the literature was examined, some studies reported the benefits of BA in patients with chronic pain and fatigue, fibromyalgia, hip OA, balance disorders, and psychosomatic problems such as sleep disorders and depression. At this point, it is emphasized that the improvements achieved with BA are associated with the increase in individuals' pain coping skills and compliance with treatment.[6-9]

To maximize patients' compliance and gains from treatment, first of all, patients' awareness should be raised. For this purpose, BA programs are applied. Although the results of BA programs in patients with hip OA have been reported in a recent study,[7] evidence showing the relationship between BA and symptoms in knee OA patients is limited. However, recent findings have also been reported. A meta-analysis published in 2024 demonstrated that mind–body exercises have significant effects on pain, stiffness, and physical function in knee OA, emphasizing the importance of body-awareness-based approaches in knee OA management.[10] Furthermore, Alpay and Şahin examined the effectiveness of basic body awareness therapy in patients with knee OA and found that it produced beneficial effects on pain, balance, muscle strength, and functionality.[11] In contrast to these interventional studies, it is also important to investigate the natural correlations between body awareness and clinical outcomes in knee OA, thereby providing complementary evidence. Pain, impaired balance, and reduced functional performance represent the main clinical challenges in knee OA,[2,12] and clarifying their relationship with body awareness may provide additional justification for the use of mind–body approaches in this population. Thus, this study aims to evaluate the relationship between BA and functional performance, pain, and static balance in women with knee OA. It is hypothesized that there would be a correlation between body awareness and pain and static balance directly. However, it is anticipated that functional performance, pain, and static balance in women with knee OA.

Therefore, this study aimed to answer the following research question: Is body awareness associated with pain severity, static balance, and functional performance in women with knee osteoarthritis?

Methods

This cross-sectional study was conducted at Hacettepe University from April 2021 to April 2022 in accordance with the principles of the Declaration of Helsinki and was approved by the Institutional Ethics Committee (Decision No: 2021/07-28, Project No: GO 21/395). Verbal and written informed consent was obtained from all participants.

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Participants

Twenty-four female patients, diagnosed with moderate unilateral knee OA by a senior orthopedic surgeon, were included in the study. The number of patients required to be included in the study was calculated with *G Power Software* (Version 3.1.9.2, Düsseldorf, Germany). In this study, it was envisaged to recruit 24 patients with knee OA to achieve 80% power at the $P < .05$ level with Irl 0.55 effect size. The assumed effect size ($f = 0.55$) was determined based on Cohen's criteria for a moderate-to-large effect size, in line with previous pilot data in musculoskeletal rehabilitation studies.[13-15]

The inclusion criteria were determined as follows: Female subjects aged 45-70 years, diagnosed with unilateral knee osteoarthritis with moderate degenerative changes and unilateral knee osteoarthritis, graded as stage 2 or 3 according to Kellgren and Lawrence radiographic classification, able to walk independently, and scored at least 24 points on the Mini-Mental Test.

Patients with the following characteristics were excluded: any history of injury to the lower extremities in the last 6 , having previous surgery of the lower extremities, having neurological or cognitive impairments, an incomplete fracture, malignancy, rheumatic diseases, a congenital or acquired deformity in the lower extremity, diagnosis of secondary OA due to trauma, having received intra-articular injections and/or physical therapy, or prior experience with complementary therapies within the last 6 months.

Outcome measures

At the beginning of the study, face-to-face interviews were used to gather data. Age, height, weight, body mass index (BMI), education level, and duration of disease were among the sociodemographic variables. All patients were evaluated for their cognitive function, pain severity, static balance, physical performance, and body awareness.

Cognitive function

The mini-mental state test (MMST) in Turkish was used to assess the patients' cognitive abilities. It was created in 1970 to measure adult cognitive deterioration quantitatively. Eleven questions make up the test, which is worth 30 points. Language, recall, concentration and computation, orientation, and short-term and immediate memory are evaluated. Better cognitive performance is indicated by higher total scores, which range from 0 to 30. Cognitive impairment is indicated by an MMST score of 18 or lower for those without education and 23 or lower for those with education.[16]

Body awareness

The Cronbach's alpha reliability coefficient for the 18-item Body Awareness Questionnaire in the current study was 0.77, indicating moderate internal consistency. The Turkish version of the questionnaire has previously demonstrated high reliability.[17]

Pain

The visual analogue scale (VAS) was used to measure the severity of knee pain. Patients were asked to identify the point on a 10 cm vertical line that best reflected their experience of pain during activities throughout the previous week.[18]

Static Balance

The static balance was assessed with a force plate (Bertec BP5050 force platform; Bertec, Corp., Columbus, OH, USA) that assesses the balance by determining the distance from the center of pressure (CoP).[19] Patients were evaluated barefoot with their arms at their sides and feet in the position they felt comfortable. They were asked to stand as balanced and stable as possible for 10 seconds on a flat surface with their eyes open and closed. Postural sway measures were obtained in cm as anteroposterior and lateral oscillations in each condition.

Functional Performance Assessment

The functional performance of the patients was evaluated with the Timed Up & Go (TUG) Test. This test is frequently used in the evaluation of functional performance in patients with knee OA. The test in this study was conducted in accordance with the Freter & Fruchter methodology.[20]

Statistical Analysis

Statistical analyses were performed using SPSS for Windows (IBM Corp., Armonk, NY, USA). Normality of continuous variables was examined

using visual inspection (histogram/Q–Q plots) and the Shapiro–Wilk test. Descriptive statistics were presented as mean ± standard deviation. Depending on data distribution, Pearson's or Spearman's correlation coefficients were used to examine associations between body awareness and clinical outcomes. To determine whether body awareness independently predicted pain severity (VAS during activity) and anteroposterior postural sway (eyes open/closed) after adjustment for potential confounders, hierarchical multiple linear regression analyses were conducted. Age, BMI, and disease duration were entered in Block 1 and body awareness (BAQ total score) was entered in Block 2. Multicollinearity was assessed using variance inflation factors (VIF). Because of the small sample size, bootstrap confidence intervals (10 000 resamples) were used for regression estimates. *P*-values < .05 were considered statistically significant.

Results

A total of 24 female patients with unilateral knee OA were included in the study. Their mean age was 55.5 ± 7.5 years and their mean BMI was 29.9 ± 5.0 kg/m^2. Socio-demographic characteristics and clinical features, including pain severity, postural sway, and body awareness scores, are summarized in Table 1 and 2.

Correlation analyses indicated significant negative associations between BA and pain severity, disease duration, and anteroposterior postural sway (eyes open/closed), while no correlations were found with lateral sway or functional performance (Table 3).

Hierarchical multiple regression analyses were performed to test whether body awareness independently predicted pain severity (VAS during activity) and anteroposterior postural sway after adjustment for age, BMI, and disease duration. Adding body awareness (BAQ total score) in Block 2 did not significantly improve the models for VAS during activity ($\Delta R^2 = 0.037$, $P = .219$), eyes-open anteroposterior sway ($\Delta R^2 = .058$, $P = .146$), or eyes-closed anteroposterior sway ($\Delta R^2 = .043$, $P = .112$). Accordingly, BAQ was not a statistically significant independent predictor in the fully adjusted models (Table 4).

In the adjusted balance models, BMI and disease duration emerged as significant predictors of anteroposterior sway. For eyes-open anteroposterior sway, higher BMI was associated with lower sway ($B = -0.024$, $P = .013$) and longer disease duration was associated with higher sway ($B = 0.031$, $P = .038$). For eyes-closed anteroposterior sway, longer disease duration remained a strong predictor ($B = 0.116$, $P < .001$) and BMI was also significant ($B = -0.042$, $P = .022$) (Table 4).

Table 1. Socio-demographic Characteristics of the Patients

Characteristics (n = 24)	X ± SD (min-max)
Age (years)	55.5 ± 7.5 (45-70)
Height (cm)	161.4 ± 4.5 (153-172)
Weight (kg)	78.2 ± 15.3 (60-119)
BMI (kg/m^2)	29.9 ± 5.0 (23.58-40.22)
K-L Classification n (%)	
Grade 2	11 (45.8)
Grade 3	13 (54.2)
Education level n (%)	
Illiterate	3 (12.5)
1-12 years	17 (70.8)
>12 years	4 (16.7)

BMI, body mass index; SD, standard deviation.

Table 2. The Clinical Features of the Patients

(n = 24)	X ± SD
Disease duration (months)	9.08 ± 3.5
Pain severity (VAS) (cm)	5.35 ± 1.92
Postural sway (cm)	
EO ant-post.	0.4684 ± 0.2193
EO lat.	0.2565 ± 0.1047
EC ant-post.	0.9251 ± 0.5541
EC lat.	0.3157 ± 0.1812
TUG (sec)	10.74 ± 1.28
BAQ (point)	88.37 ± 10.27

BAQ, Body Awareness Questionnaire; cm, centimeter; EO ant-post., eyes opened anterior-posterior oscillation range; EO lat., eyes opened lateral oscillation range; EC ant-post., eyes closed anterior-posterior oscillation range; EC lat., eyes closed lateral oscillation range; SD, standard deviation; sec, second; TUG, Timed Up & Go Test; VAS, visual analogue scale; X, mean.

Table 3. The Correlations Between Body Awareness and Disease Duration, Pain Severity, Postural Sway, and Functional Performance

BAQ	*r*	*P*
Disease duration	−0.680	**< .001***
Pain		
Activity	−0.557	.005*
Balance		
EO ant-post. sway	−0.456	**.025***
EO lat. sway	−0.210	.305
EC ant-post. sway	−0.738	**< .001***
EC lat. sway	−0.078	.716
TUG	−0.261	.218

*$P < .05$. BAQ, Body Awareness Questionnaire; EC ant-post. sway, eyes closed anterior-posterior oscillation range; EC lat. sway, eyes closed lateral oscillation range; EO ant-post. sway, eyes opened anterior-posterior oscillation range; EO lat. sway, eyes opened lateral oscillation range; TUG, Timed Up & Go Test.

Discussion

In this study, body awareness showed significant bivariate associations with pain severity during activity and anteroposterior postural sway in female patients with knee OA, particularly under eyes-closed conditions. However, in hierarchical regression models adjusting for age, BMI, and disease duration, body awareness did not remain a statistically significant independent predictor of pain or anteroposterior sway. This attenuation suggests that the relationship between body awareness and these outcomes may overlap with clinical factors such as adiposity and chronicity, both of which are known to influence pain processing and postural control.

Pain as the primary symptom of knee OA leads patients to seek medical help and restricts functionality.[21] According to recent systematic reviews, a complex interaction between a number of factors, such as lifestyle choices, cognitive functions, and mechanisms of peripheral and central sensitization, results in the pain associated with knee OA.[22,23] In the literature, the relationship between knee OA patients' pain and body awareness has not been investigated. According to the results, patients with knee OA also show indications of reduced body awareness similar to other chronic pain conditions.[7,24] It is well recognized that the neuromuscular system undergoes structural alterations as a result of the cognitive, emotional, behavioral, social, and motivational elements that contribute to pain and pain-related behaviors. Anxiety over the course of the disease, fear of worsening symptoms, and unfavorable social interactions all have a big impact on how patients view their bodies and their functional capacities.[25,26]

These findings support the hypothesis that pain severity is associated with reduced BA in female patients with knee OA, similar to the results of previous studies that were related to different chronic diseases.[27] It

Table 4. Hierarchical Multiple Regression Models Predicting Pain Severity and Anteroposterior Postural Sway

Outcome	Predictor	B	SE	Std. β	*P*	95% CI/Model Fit
Pain severity (VAS during activity)	Constant	7.678	6.040		.219	[−4.963, 20.320] Model fit: R^2(Block 1) = 0.531; R^2 (Block 2) = 0.568; ΔR^2 = 0.037; *P*Δ = .219
	Age (years)	−0.045	0.040	−0.179	.275	[−0.130, 0.039]
	BMI (kg/m^2)	0.120	0.071	0.308	.110	[−0.030, 0.269]
	Disease duration (months)	0.129	0.118	0.237	.287	[−0.117, 0.375]
	Body awareness (BAQ total)	−0.051	0.041	−0.275	.219	[−0.136, 0.033]
Anteroposterior sway (eyes open)	Constant	1.947	0.722		.014	[0.435, 3.459] Model fit: R^2(Block 1) = 0.466; R^2 (Block 2) = 0.524; ΔR^2 = 0.058; *P*Δ = .146
	Age (years)	−0.007	0.005	−0.255	.144	[−0.018, 0.003]
	BMI (kg/m^2)	−0.024	0.009	−0.532	.013	[−0.041, −0.006]
	Disease duration (months)	0.031	0.014	0.508	.038	[0.002, 0.061]
	Body awareness (BAQ total)	−0.007	0.005	−0.344	.146	[−0.017, 0.003]
Anteroposterior sway (eyes closed)	Constant	2.762	1.433		.069	[−0.238, 5.762] Model fit: R^2(Block 1) = 0.664; R^2 (Block 2) = 0.706; ΔR^2 = 0.043; *P*Δ = .112
	Age (years)	−0.004	0.010	−0.051	.700	[−0.024, 0.016]
	BMI (kg/m^2)	−0.042	0.017	−0.380	.022	[−0.078, −0.007]
	Disease duration (months)	0.116	0.028	0.746	< .001	[0.058, 0.175]
	Body awareness (BAQ total)	−0.016	0.010	−0.297	.112	[−0.036, 0.004]

Block 1: age, BMI, disease duration; Block 2: + body awareness.
Multicollinearity diagnostics were acceptable (VIF range 1.11-2.07).
BAQ, Body Awareness Questionnaire; BMI, body mass index; VAS, visual analogue scale.

has also been stated that body image affects the level of body awareness.[28] Erdoganoglu et al[29] reported that there is a relationship between the pain severity and body image of patients in the early stage of OA. They also reported that patients who suffer from severe pain have lower body image perceptions and that body image decreases with the progression of the disease. Similarly, Levenig et al[30] stated that the low body image might be due to the severity of pain. Considering previous studies, both pain severity and its negative effects on body image may have negatively affected the results of the patients' body awareness level from the early stage of the disease. For those living with pain, the level of body awareness could play an important role in coping with the pain. Recent studies also emphasize the role of body awareness and mind-body therapies in rehabilitation approaches for treating OA.[31,32] The findings are consistent with these recent perspectives and further emphasize the importance of addressing body awareness in the management of knee OA. In addition, contemporary studies indicate that pain in OA is most commonly assessed using the VAS, which supports the methodological choice made in this study.[33]

Body awareness was related to anteroposterior sway but not to mediolateral sway. One plausible biomechanical explanation is that quiet standing control in the sagittal plane relies heavily on the ankle strategy and proprioceptive inputs around the ankle and knee, which may be more sensitive to pain-related sensorimotor changes and interoceptive attention. In contrast, mediolateral stability is often more dependent on hip abductor/adductor control and base of support characteristics; in a comfortable stance, mediolateral sway may be relatively small and less sensitive to detect subtle changes associated with body awareness.

Given the cross-sectional design, no causal inference can be made. It remains unclear whether reduced body awareness contributes to higher pain and impaired balance, or whether persistent pain and structural changes in knee OA lead to a secondary decline in body awareness. Longitudinal and interventional studies are needed to clarify the directionality of these associations.

This study demonstrated a moderately significant correlation between the level of body awareness and disease duration. In relation to the results of this study, the level of body awareness decreases as the disease progresses. It should be emphasized that the disease duration of the patients included in this study was relatively shorter compared to the existing literature.[34,35] However, no other study exists in the literature presenting the association between the level of body awareness and functional performance in patients with knee OA. The findings suggest that adding approaches aimed at enhancing body awareness to treatment programs from the early stages of the disease could be beneficial in the management of the condition.

In a recent study, it was determined that the damage to the knee articular cartilage progresses with increasing severity of knee osteoarthritis, which negatively affects the static and dynamic balance and causes its decrease.[36] Pain and muscle weakness can affect postural oscillation and lead to changes in body perception of the knee.[37] In this study, higher body awareness was associated with lower eyes-open and eyes-closed anteroposterior postural sway (i.e., reduced oscillation distance), indicating better static balance. These results add to the findings of existing studies[36,37]showing that pain affects static balance and body perception. Hassan et al investigated the possible independent predictors of static balance in knee OA. In the present study, higher body awareness was associated with reduced anteroposterior postural sway (i.e., better static balance), particularly under eyes-closed conditions. These findings are consistent with the notion that altered body perception/awareness may be linked to postural control in knee OA, although the direction and strength of this relationship may vary depending on the construct assessed (e.g., body perception vs. body awareness) and the balance metric used. Importantly, given the high BMI of the sample and the established influence of adiposity on postural control,[38] BMI may partly account for the observed bivariate associations. In line with this, the adjusted regression analyses showed that BMI and disease duration were significant predictors of anteroposterior sway, while the contribution of body awareness attenuated after controlling for these clinical covariates. Because evidence on the relationship between body awareness and static balance in knee OA remains limited, future studies with larger samples and longitudinal designs are warranted to clarify these associations.

Another important clinical aspect of the knee OA process is a decline in functional performance.[39] Pain is emphasized as a possible cause of the decline in functional performance observed in knee OA. Patients restrict their movements due to knee pain and decrease their functional

performance levels.[40] Especially as the disease progresses, limitation of movement and pain increase, and functional performance decreases further.[12] Consistent with previous studies, no correlation was found between the level of body awareness and functional performance in the current study. A possible reason for this could be that grade 2 and 3 knee OA patients were included, and their mean disease duration was relatively short (9.08 ± 3.5 months) according to degenerative disease. These findings are in line with another study that assessed functional performance with the TUG test in patients with grade 2 and 3 knee OA and reported no significant correlation between body image and functional performance.[29] Similarly, Erden et al[41] reported that there was no relationship between the level of body awareness and functional performance in sedentary young older adults. Furthermore, advances in functional assessment methods such as the TUG test with equipment emphasize the importance of creating a precise profile in knee OA;[42] although the traditional TUG was used in this study, future studies could integrate these analytical methods to reveal the relationship between BA and functional performance more objectively.

In conclusion, there was a moderate to good correlation between BA and disease duration, pain severity, and antero-posterior postural sway in both eyes opened and closed conditions in the early and middle stages of knee osteoarthritis. Healthcare professionals should be aware of the relationship between body awareness and osteoarthritis symptoms and should take this into account in the management of the disease from its early stages. At the same time, understanding the factors that negatively affect body awareness in patients with knee OA can assist clinicians in enhancing the effectiveness of the rehabilitation approaches.

Limitations

In light of the findings of this study, several limitations should be considered. First, the cross-sectional design precludes causal inference and the direction of the relationship between body awareness, pain, and balance remains uncertain. Second, although an a priori power analysis was performed, the sample size was relatively small and included only female patients, which may limit statistical power for multivariable analyses and generalizability. Third, although adjustments were made to the main analyses for age, BMI, and disease duration, residual confounding by other factors (e.g., psychosocial variables, physical activity level, and medication use) cannot be excluded. Finally, functional performance was assessed using the TUG test; more sensitive instrumented or kinematic assessments and task-specific functional measures may better capture subtle changes related to body awareness in future research.

Data Availability Statement: The data that support the findings of this study are available on request from the corresponding author.

Ethics Committee Approval: Ethical committee approval was received from the Ethics Committee of University of Hacettepe (Approval no: GO 21/395, Date: 28/07/2021).

Informed Consent: Written informed consent was obtained from all participants.

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