HHS Public Access
Author manuscript
J Orthop Res. Author manuscript; available in PMC 2024 December 01.

Published in final edited form as:
J Orthop Res. 2023 December ; 41(12): 2629–2637. doi:10.1002/jor.25624.

Gait speed and kinesiophobia explain physical activity level in adults with osteoarthritis: A cross-sectional study

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Abstract

Identifying potential contributing factors for physical inactivity in people with knee osteoarthritis is vital for designing practical activity promoting interventions. Walking is a common activity, but it is unknown how gait characteristics may influence physical activity and if psychological factors, specifically fear of movement (kinesiophobia), contribute to this relationship. The aim of our study was to investigate the contributions of select gait parameters and kinesiophobia to activity levels. Cross-sectional data from 40 participants (F 24 | M 16; age 57.6 ± 8.9 years; BMI 34.7 ± 7.0 kg/m^2) with uni- or bilateral knee osteoarthritis were included. Physical activity and kinesiophobia were assessed by self-report using the University of California, Los Angeles activity rating scale and Tampa Scale for Kinesiophobia, respectively. Gait parameters were collected with three-dimensional gait analysis while participants walked on an instrumented split-belt treadmill at a self-selected speed. Higher peak sagittal plane joint moments at the ankle (rho = 0.418, P = 0.007), and hip (rho = 0.348, P = 0.028), faster self-selected gait speed (rho = 0.553, P < 0.001), and less kinesiophobia or fear of movement (rho = −0.695, P < 0.001) were independently related to higher physical activity level in adults with knee osteoarthritis. In hierarchical regression models, after accounting for covariates, only self-selected gait speed, and kinesiophobia significantly contributed to explaining the variation in physical activity level. Statement of Clinical Significance: Interventions aimed at improving physical activity participation in those with lower limb osteoarthritis should consider assessing the contribution of pain-related fear of movement.

Keywords

gait; joint loading; kinesiophobia; knee osteoarthritis; physical activity

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Author Contribution Statement: BA contributed to the conception and design of the study, acquisition of data, data analysis and interpretation, and drafting the article. CH contributed to acquisition of data and revising the article critically. KCF contributed substantially to the design of the study and revising the article critically. All authors have read and approved the final submitted manuscript.

Conflict of interest: All authors declare that they have no conflicts of interest.

1. Introduction

In knee osteoarthritis (OA), the benefits of physical activity (PA) for maintaining function and relieving symptoms are well documented.[1] However, over 50% of people with OA do not meet recommended PA guidelines.[2] Walking is the most common form of PA reported by adults with arthritis[3] but little is known regarding whether individual gait characteristics could impact activity level. Identifying specific gait characteristics and other contributing factors that could explain the low activity levels commonly observed in this population may uncover better treatment approaches for improving PA participation.

People with knee OA tend to demonstrate walking gait deviations, particularly in the affected knee and adjacent joints (ankle and hip).[4,5] In knee OA, the peak external knee adduction moment and impulse (time integral of loading) have been linked to disease severity and symptoms.[6–9] Further, it has been suggested that patients with knee OA compensate for a higher than normal frontal plane (knee adduction) moment by producing a counteractive sagittal plane (knee flexion-extension) moment to increase the dynamic lateral stability of the knee joint.[10,11] Several studies have also reported compensatory biomechanical changes occurring in the ankle and hip joint moments that are related to knee OA.[4,12–14] Compared to asymptomatic controls, adults with knee OA demonstrate decreased peak ankle dorsiflexion and peak hip extension moments.[12,13] The compensatory gait mechanics commonly observed are proposed to be a mechanism to minimize weight-bearing pain on the affected joint.[15,16] Joint mechanics in this population have been extensively characterized and investigated in relation to OA and accompanying symptoms. However, it is unclear whether the OA-specific gait mechanics that are commonly linked to severity and symptoms, may also be related to the ability of this population to be physically active.

Another potential barrier to PA in OA is pain-related avoidance behaviors. Chronic pain in OA can exacerbate psychological distress that affects physical movement and activity, such that strategies are adapted to avoid movements that are thought to cause pain.[17,18] Kinesiophobia is a term that describes avoiding physical movements and activities in response to a debilitating fear of the possibility of experiencing pain rather than an actual noxious stimulus.[19] A greater degree of kinesiophobia (more fear) has been linked to lower PA in adults with knee OA.[20,21] Adults with knee OA that report greater kinesiophobia also demonstrate lower knee flexor and extensor muscle strength,[20,22] which are muscles that are vital for controlling knee joint mechanics.[11,23] Thereby, kinesiophobia may also potentially be related to OA-specific gait mechanics. However, no studies have investigated the combined effects of gait mechanics and kinesiophobia on PA in this population, and it is unknown whether fear may be a more significant contributor to explaining activity levels in this population.

The aim of this study was to investigate the associations between walking gait mechanics, kinesiophobia, and PA in people with knee OA; and explore whether kinesiophobia may contribute to explaining PA beyond what is explained by significant gait measures. We hypothesized that in people with knee OA (i) higher joint moments (ankle, knee, and hip) during walking gait are associated with higher PA; and (ii) lower kinesiophobia (less fear) significantly contributes to explaining higher PA more than significant gait measures. Knowledge about how different gait measures may contribute to explaining PA in the presence of kinesiophobia (fear of movement) could lead to identifying specific gait parameters and psychological barriers that could be targeted in activity promoting interventions.

2. Methods

2.1 Participants

Forty participants with uni- or bilateral knee OA were included in this cross-sectional analysis. Participants were recruited from a local surgical practice and an IRB approved database maintained by our institution through the Center for Clinical and Translational Studies, using ICD 10 codes (M17) specifically for OA of the knee. To meet inclusion criteria participants had to be 18 years and over with physician diagnosed uni- or bilateral knee OA. Participants were excluded if they reported any of the following: any muscular or neurologic condition affecting lower limb function, or an inability to walk without an assistive device. Participants that self-reported concomitant hip OA were included if the joint was reported as being asymptomatic. To be considered asymptomatic in this study, participants had to respond “no” to a question which inquired about the affected joint having pain, stiffness, or aching on most days. Two participants reported a prior history of total joint arthroplasty in one of their lower limb joints (hip or knee). The self-reported length of time that had lapsed since their procedures were approximately 7 and 9 years, and neither participant reported symptoms or any procedure related issues with the replaced joint. This study was approved by the University of Illinois at Chicago Institutional Review Board. Written informed consent was obtained from all participants.

A clinical interview was conducted where demographic and anthropometric measures were acquired for all participants. To characterize our sample, participants also completed the Charlson Comorbidity Index, a summary measure of comorbidity severity,[24] and the Knee Injury and Osteoarthritis Outcome Score (KOOS). The KOOS is a knee specific instrument evaluating symptoms and function over the past week in individuals with knee injury or OA.[25] It has 5 subscales that include items rated on a 5-point Likert scale: pain (9 items), other symptoms (7 items), activities of daily living (17 items), sport & recreation function (5 items), and knee-related quality of life (4 items). A normalized score for each subscale is calculated with 100 indicating no symptoms and 0 indicating extreme symptoms.

2.2 Physical activity (PA)

PA was self-reported using the University of California Los Angeles (UCLA) activity rating scale.[26] The UCLA activity rating scale is a single item that intends to measure global PA level on a scale of 1 out of 10 activity levels. The instrument contains ten statements describing a variety of activity levels that range from ‘wholly inactive’ (level 1), to ‘regular participation in impact sports’ (level 10). Participants chose one level that best described their current activity level. The UCLA activity scale is a valid and feasible measure to assess PA in patients with OA of the hip or knee.[27]

2.3 Kinesiophobia

The Tampa Scale for Kinesiophobia (TSK) was used to assess the degree of kinesiophobia or debilitating fear of physical movement and activity due to feelings of vulnerability to painful (re)injury.[28] It consists of 17-items, each item is provided a 4-point Likert scale with scores ranging from ‘strongly disagree’ to ‘strongly agree’. The lowest possible score is 17 and indicates no kinesiophobia (no fear of movement), while the highest score is a 68 and indicates extreme fear of movement. This instrument is a reliable and valid measure in chronic pain population.[29,30]

2.4 Walking gait analysis

The gait analysis data were collected via an 8-camera, 3D motion capture system (Motion Analysis Co., Santa Rosa, CA, USA) operating at 120 Hz and a synchronized custom built split-belt instrumented (AMTI) treadmill (Treadmetrix) operating at 1200 Hz. The cameras and system were calibrated before each data collection. Passive reflective markers were placed bilaterally over the following bony landmarks: second and fifth metatarsal head, lateral and medial malleolus, heel, lateral and medial femoral condyle, greater trochanter, anterior superior iliac spine, posterior superior iliac spine, sacrum, iliac crest, mid-thigh, and mid- shank. Following a static trial, participants began walking on the treadmill which was set to the lowest possible speed (0.30 m/s) with zero incline. Participants were blinded to the speed of the treadmill and were instructed to verbally tell the assessor to adjust their speed (increase/decrease/maintain) to a point where it was “a comfortable everyday walking pace that did not feel unsafe”. Participants were then given an acclimation period to adjust to the treadmill at their preferred walking speed before data was recorded. While maintaining their walking speed a 5-minute dynamic trial was recorded with kinematic and kinetic data collected synchronously. Within the last 2-minutes of the dynamic trial a period of 20 consecutive steps was identified for each participant where each foot hit the correct force plate, and there were no abnormal lower- or upper-body movements. These data were then cleaned and processed for analysis. Marker trajectories and ground reaction forces were filtered using 4^{th} order low-pass Butterworth filters with a cutoff frequency of 6 Hz. Ankle and knee joint centers were estimated as the midpoints between the medial and lateral malleoli and femoral condyles, respectively. The hip joint center was estimated using the Harrington method.[31] Joint moments were calculated using inverse dynamics and resolved in the coordinate system local to each joint.[32] The following peak joint moments (expressed as external moments) from the entirety of stance phase were calculated using Visual 3D software (C-Motion, Inc.): hip flexion, knee flexion, ankle dorsiflexion, and knee adduction. Additionally, the knee adduction moment impulse (time integral of knee adduction moment) was calculated for the entirety of the stance phase. A vertical ground reaction force of 20 N was used to detect the beginning and end of the stance phase. The average peak or greatest magnitude of each moment within stance phase across 10 steps for each limb was calculated. There were no significant differences in any gait measures between-limbs in unilateral and bilateral cases ($P > 0.05$). Further, there were no significant differences between cases in the affected (unilateral) and most-affect (bilateral) limbs ($P > 0.05$; Supporting Information: Table S-1). Therefore, the sample was analyzed as a whole and only the self-reported affected/most affected (bilateral-OA cases) lower limb was included in the final analyses. The most affected side was defined as the knee that was self-reported as most troublesome or had worse symptoms (pain, aching, or stiffness on most days). Peak joint moments were normalized to %body weight*height.[33]

2.5 Statistical analysis

All data analyses were performed using SPSS (version 28; SPSS). Descriptive statistics were calculated for all primary measures and characteristic variables. All variables were checked for normality using the Shapiro-Wilk's test. The UCLA score significantly deviated from normality (W [40] = 0.92, $P = 0.01$). As a result, the non-parametric Spearman's correlation (*rho*) analysis was used to explore the strength of the bivariate correlations between all dependent (UCLA), independent (gait measures and kinesiophobia), and potential covariate (age, BMI) variables. An exploratory Spearman's correlation (*rho*) analysis was also conducted to explore bivariate correlations between KOOS subscale scores and all gait parameters (Supporting Information: Table S-2). A Mann-Whitney *U* test was performed to determine whether there was a sex difference in the UCLA score. Prior to parametric analyses, the UCLA score was transformed using a logarithmic transformation. The α value was set at 0.05 for all analyses.

Hierarchical regression analysis was conducted to determine the independent contributions of associated gait measures and kinesiophobia on PA level. Due to the high correlations between biomechanical measures, we performed separate regression analyses and monitored the presence of any multicollinearity by checking whether the variation inflation factor was above 10.[34] In each separate regression analysis, significant demographic characteristics were entered in the first step, followed by a significant biomechanical measure with gait speed, then lastly kinesiophobia (TSK) was entered in the third and final step. Kinesiophobia was entered last to determine if fear beliefs provided any significant additional predictive information when accounting for the other variables in the preceding steps. The UCLA score was treated as the dependent variable in each model. Using G*Power[35] we determined that under these conditions ($\alpha = 0.05$; tested predictors = 3, total predictors in model = 4) a sample size of 40 subjects provides 80% power for detecting the minimal detectable effect size (Cohen's f^2)[36] of 0.208. Finally, we conducted a sensitivity analysis removing participants from the analysis who reported concomitant hip OA or a previous total joint replacement.

3. Results

Participant descriptive characteristics are presented in Table 1. Of the 40 participants included in the analyses the majority were predominantly female (60%), Black or African American (72.5%), with bilateral knee OA (70%), and had a BMI of 30–39.9 kg/m^2 (45%). There were significant correlations between the UCLA score and TSK, peak ankle dorsiflexion moment, peak hip flexion moment, and gait speed (Table 2 and Supporting Information: Figure S-1). There were no significant correlations between the UCLA score and peak knee flexion moment, peak knee adduction moment or impulse, which were excluded from subsequent regression analyses. The UCLA score was significantly correlated with KOOS pain ($rho = 0.520$, $P < 0.001$) but not with age ($rho = 0.083$, $P = 0.611$) or body mass index ($rho = -0.147$, $P = 0.366$). There was a significant sex difference in the UCLA score, with males (*Mdn* = 6.0) reporting significantly higher activity levels than females (*Mdn* = 4.0), $U = 104.5$, $P = 0.014$. Sex was accounted for in the first step of the hierarchical regression analyses. The KOOS pain was not included in analyses because it was highly correlated with the TSK (*rho* = −0.708, $P < 0.001$).

3.1 Hierarchical regression analyses

The first step of the regression analysis was the same for all models, with sex being entered first. Sex was a significant contributor to the regression models and significantly accounted for approximately 14% of the variance in the UCLA score (Table 3). Male sex was related to higher activity. There was a significant increase in predictive power for subsequent steps in both models.

In the second step, each biomechanical factor (peak ankle dorsiflexion moment or peak hip flexion moment) with gait speed were entered into a separate regression model. These measures significantly explained an additional 27.6% (peak ankle dorsiflexion moment model) to 26.7% (peak hip flexion moment model) of the variance in the UCLA score and the change in R^2 was significant in each model (Table 3). In each model, gait speed was the only gait measure that remained significant. In both models, higher self-selected gait speed explained higher PA even after controlling for sex and peak ankle dorsiflexion moment (Table 4) and peak hip flexion moment (Table 5). Between the models in this step, the model containing peak ankle dorsiflexion moment with gait speed explained the highest amount of variance in the UCLA score (adjusted $R^2 = 0.368$, $P < .001$).

The TSK score was entered into the third and final step of each model to determine whether it contributed above and beyond what was explained by sex and gait measures. The TSK score significantly explained an additional 18.9% to 19% of the variance in the UCLA score and again the change in R^2 in each model was significant (Table 3). In both models, participants that were less fearful of movement reported higher PA, even after controlling for sex and gait measures (Table 4 and Table 5). In step three the full set of independent variables accounted for 59.6% (Supporting Information: Figure S-3) to 60.5% (Supporting Information: Figure S-2) of the variance in the UCLA score in their models. The full model containing the TSK with sex, gait speed, and peak ankle dorsiflexion moment explained the highest amount of variance in the UCLA score (adjusted $R^2 = 0.550$, $P < 0.001$; Table 3). When participants with self-reported concomitant hip OA or total joint replacement were excluded from the analyses, the results were unchanged.

4. Discussion

The primary aim of this study was to determine the relationship between walking gait parameters and PA in people with knee OA; and explore how kinesiophobia contributes to these relationships. We found that gait speed, and greater peak sagittal plane joint moments at the ankle and hip were independently associated with higher PA. Additionally, in hierarchical regression analysis, kinesiophobia significantly contributed to explaining the variance in PA levels in each model. Even though the change in R^2 was not more than the preceding steps, the final step in each model that included the TSK explained the highest amount of variability in PA level.

In bivariate analyses, gait speed, and peak sagittal plane ankle and hip joint moments were significantly related to PA level. However, peak sagittal plane knee joint moment was not related to PA level. This may be because the ankle and hip compensate for knee impairment. For example, studies investigating the effects of total knee arthroplasty on joint mechanics, reported that although there were significant improvements in self-reported knee pain and function, greater biomechanical changes occurred at the ipsilateral hip and ankle joints than at the operated knee.[37,38] Authors of both studies suggested that the ankle and hip compensated for impaired knee function prior to the replacement and recovered following improvements at the knee. Lower-extremity joint moments within the sagittal plane are related to propulsion and gait speed.[39] Therefore, the associations that were observed may also reflect slower walking speeds rather than OA pathology related mechanics.

Notably, the peak knee adduction moment and impulse were not related to PA in our sample. The frontal plane knee adduction joint moment is related to medial knee joint loading, which is why it is considered as a proxy for structural OA progression.[8] Frontal plane knee adduction moment impulse is also an important gait feature related to disease severity[6] and symptoms[9] in knee OA. Although these mechanical parameters at the knee are commonly associated with disease related structural and symptomatic features, our findings provide evidence suggesting that they may not pose a significant barrier to the ability to participate in higher activity levels.

The self-selected gait speed in our sample was low (~0.6 m/s). Previous reports suggest that self-selected gait speed may be indicative of overall knee joint health.[40] Individuals with knee OA walk at slower self-selected gait speeds compared to asymptomatic age-matched controls.[12,41,42] It has been suggested that walking at slower speeds could be a strategy to reduce frontal plane knee joint loading in adults with knee OA.[43] Walking at speeds at or below 0.6 m/s can also be indicative of poor mobility and the need for mobility-specific training.[44] Although treadmill walking speed may not be completely comparable to overground walking, our findings suggest our sample may include individuals with a lower health and functional status that may avoid walking at a faster speed because it would require more exertion. As a result, these individuals might avoid more strenuous activities which could explain why those that walked slower reported lower PA levels. Additionally, slower gait speed was independently related to greater kinesiophobia. This finding suggests that fear played a role in the self-selection of gait speed. However, we did not ask participants about their experience with treadmill walking, thus the slow gait speed could also be reflective of inexperience with treadmill walking or fear that walking on a treadmill may exacerbate their symptoms. Allowing participants to walk at their self-selected speed may allow for proper generalization to an individual’s actual joint movement patterns[45] and also psychological traits that may impact selection of a comfortable walking speed. Future intervention-based investigations should consider inquiring participants about their treadmill walking experience. A further analysis of these relationships in a faster walking cohort and comparison to overground walking may be warranted.

Kinesiophobia significantly contributed to explaining PA level and remained a significant independent variable even after accounting for all other measures. The TSK values in our sample are within the averages reported by similar knee OA cohorts (37.1– 44.7).[21,22] These studies linked higher TSK scores to impaired strength,[22] lower physical function, and lower PA levels.[21] In our study, greater kinesiophobia was also related to worse activity-related knee pain (KOOS pain). Several studies have reported similar relationships between the TSK with the KOOS pain and other pain measures.[46–49] Although the TSK and the KOOS pain are both pain-related measures, only the TSK was associated with self-selected gait speed in our bivariate analysis. This finding suggests that kinesiophobia and activity-related knee pain may operate independently to impact PA. Previously, we reported that kinesiophobia was related to knee muscle strength and PA in adults with knee OA.[20] In that investigation, kinesiophobia mediated the association between muscle strength and PA to a greater extent than activity-related knee pain. Together these findings support that pain-related fear in this population could negatively impact the capacity of certain physical components (e.g., strength and gait) that are important for PA. Further, an individual with a fear of movement or activities involving their affected knee may intentionally refrain from performing to their full capacity to avoid possible pain and/or re-injury. Over time these activity avoidance behaviors can exacerbate physical (e.g., loss of strength or mobility) and psychological (e.g., anxiety, more fear) consequences, which could potentially turn into a vicious cycle accelerating disability. Including the TSK as a supplement with other pain measures may help create a patient profile to identify individuals that demonstrate fear-avoidance behaviors.

The findings of our study have important implications for OA research that seeks to improve PA level. The TSK is a tool that could potentially be utilized in studies or in the clinic to help explain why some individuals may not perform as expected on clinical tests or measures. It may also help create a better patient profile and uncover why certain individuals lack adherence to certain interventions or protocols. Overcoming fear of activities is thought to occur through guided gradual exposure to a feared activity.[19] Moreover, it is thought that as a patient confronts a feared activity gradually without the feared event (pain or injury) their tolerance to the feared stimuli increases, therefore their phobia of that activity will consequently diminish. As a result, the activity will no longer be avoided. Being able to identify individuals that are more likely to demonstrate higher kinesiophobia could be beneficial for developing targeted interventions that include gradual exposure to certain movement patterns or activities. For example, gait training protocols aimed at improving gait speed through gradual exposure to higher speeds could potentially help reduce fear of walking, but also, in turn, may improve PA level in this population. Future longitudinal work is needed to investigate whether training protocols that implement gradual exposure to feared activities, can possibly promote strength, efficient gait mechanics, and ultimately sustainable PA levels in this population.

4.4 Limitations

There are a few limitations that should be noted. First, we evaluated PA through a self-report measure. Self-reported measures of PA may be subject to under or overestimation of activity and potentially recall bias. These findings may differ with quantitative measures of activity that are collected using actigraphy. To support these findings, these relationships should be examined in a larger sample size with different measures of PA. Further, the presented hypotheses and results are from a cross-sectional analysis. As such, we were unable to determine the effect of temporal changes in the included measures. Future investigations should consider examining the longitudinal interrelationships between gait speed, kinesiophobia, and PA participation, which may help reveal the true directionality between these measures in adults with knee OA. We also did not differentiate between grades of OA or inquiry participants on pain during the walking trial. Therefore, the interrelationships between our measures may vary according to disease severity or symptoms. Additionally, given the small sample size we were conservative with the number of independent variables that were included in our analyses. These findings are based solely on the measures that were evaluated and larger investigations of different gait parameters and other psychological measures may be warranted. Lastly, 70% of our sample had a BMI over 30, therefore, it may be warranted to reexamine these relationships in a larger sample comparing different weight categories.

5. Conclusions

Overall, higher self-selected gait speed and less fear of movement were significant contributors to explaining higher PA level in adults with knee OA. Interventions to improve PA participation should consider these factors. Assessing kinesiophobia may help with identifying patients who might need more attention or feedback during physical assessments or gait analyses.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements:

The authors thank Anusha Jalasutram, BS, Aman Tineh, BS, and Samuel Chmell, MD, for their assistance with participant recruitment. This work was funded by a University of Illinois at Chicago Center for Clinical and Translational Sciences Pilot Grant (UL1TR002003). The funding source had no such involvement in study design; in the collection, analysis and interpretation of data; in the writing of the report; and in the decision to submit the article for publication. Dr. Aydemir is supported by Grant T32 AR007611-19 from the National Institute of Arthritis and Musculoskeletal and Skin Diseases.

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Table 1.

Descriptive characteristics of all participants (*n* = 40).

Characteristic	Value
Bilateral knee OA cases, *n (%)*	28 (70)
Concomitant hip OA cases, *n (%)*	2 (5.0)
Sex (Female), *n (%)*	24 (60)
Race, *n (%)*	
Black or African American	29 (72.5)
White	10 (25)
Other	1 (2.5)
Charlson comorbidity index, *n (%)*[a]	
0	7 (17.5)
1–2	19 (47.5)
3–4	11 (27.5)
≥ 5	3 (7.5)
Analgesic use, *n (%)*[b]	25 (62.5)
BMI CDC classifications, *%*	
Normal weight (18.5–24.9 kg/m^2)	3 (7.5)
Overweight (25–29.9 kg/m^2)	9 (22.5)
Obesity class I or II (30–39.9 kg/m^2)	18 (45)
Obesity class III (≥ 40 kg/m^2)	10 (25)
BMI, *kg/m^2*	34.69 ± 7.00
Age, *y*	57.55 ± 8.95
Weight, *kg*	99.61 ± 21.53
Height, *m*	1.69 ± 0.09
KOOS subscales, *0–100*	
Pain	53.61 ± 23.28
other Symptoms	53.48 ± 24.46
Function in daily living	58.98 ± 22.87
Function in sport & recreation	34.50 ± 32.14
Knee-related quality of life	35.78 ± 24.18
UCLA, *1–10*	4.97 ± 2.14
TSK, *17–68*	39.98 ± 7.54
Peak joint moments, *%Bw*Ht*	
Ankle dorsiflexion	6.40 ± 1.76
Knee flexion	3.26 ± 1.41
Hip flexion	3.16 ± 1.60
Knee adduction	5.79 ± 2.32
Peak knee adduction moment impulse, *%Bw*Ht*s*	3.21 ± 1.66
Gait speed, *m/s*	0.57 ± 0.21

Note. Data under "Value" presented as mean ± standard deviation or frequencies (%).

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Abbreviations: BMI, Body mass index; CDC, Centers for Disease Control and Prevention;

KOOS, Knee Injury and Osteoarthritis Outcome Score; TSK, Tampa Scale for Kinesiophobia; UCLA, University of California Los Angeles activity scale.

[a]Higher index indicates greater severity of comorbid diseases.

[b]Self-reported use of analgesic for knee at least 1 time per week.

Table 2.

Relationship between UCLA score, kinesiophobia, and all gait parameters of interest ($n = 40$).

Predictors	UCLA	2	3	4	5	6	7
2. TSK	**−0.695** ***P* < 0.001**						
3. Peak ADFM	**0.418** ***P* = 0.0007**	−0.282 *P* = 0.078					
4. Peak KFM	0.110 *P* = 0.499	−0.232 *P* = 0.149	0.216 *P* = 0.181				
5. Peak HFM	**0.348** ***P* = 0.028**	−0.227 *P* = 0.158	**0.668** ***P* < 0.001**	0.242 *P* = 0.132			
6. Peak KAM	0.188 *P* = 0.246	−0.265 *P* = 0.099	0.149 *P* = 0.359	0.156 *P* = 0.336	0.301 *P* = 0.059		
7. Peak KAM impulse	0.153 *P* = 0.345	−0.236 *P* = 0.142	0.066 *P* = 0.687	0.091 *P* = 0.577	0.199 *P* = 0.219	**0.898** ***P* < 0.001**	
8. Gait speed	**0.553** ***P* < 0.001**	**−0.342** ***P* = 0.031**	**0.796** ***P* < 0.001**	0.147 *P* = 0.366	**0.573** ***P* < 0.001**	0.021 *P* = 0.896	−0.087 *P* = 0.594

Note. Spearman's correlation coefficients with corresponding *P* values. Statistically significant values are in bold.

Abbreviations: TSK, Tampa Scale for Kinesiophobia; ADFM, ankle dorsiflexion moment; KFM, knee flexion moment; HFM, hip flexion moment; KAM, knee adduction moment; UCLA, University of California Los Angeles activity scale.

Table 3.

Model summary parameters of hierarchical linear regression analyses explaining physical activity level (UCLA score) with sex, gait measures, and fear of movement (TSK) as independent variables entered into each model in successive steps (*n* = 40).

Dependent variable	Step	Independent variables	R^2	Adjusted R^2	ΔR^2	ΔF	Sig. of ΔF	Sig. of Model
UCLA score ^{T}		**Model 1**						
	1	Sex	0.140	0.117	0.140	6.19	0.017	0.017
	2	+ Peak ADFM + GS	0.416	0.368	0.276	8.52	<0.001	<0.001
	3	+ TSK	0.605	0.560	0.189	16.72	<0.001	<0.001
		Model 2						
	1	Sex	-	-	-	-	-	-
	2	+ Peak HFM + GS	0.407	0.357	0.267	8.10	0.001	<0.001
	3	+ TSK	0.596	0.550	0.190	16.43	<0.001	<0.001

Note.

^{T}Log-transformed UCLA score.

Abbreviations: ADFM, ankle dorsiflexion moment; GS, self-selected gait speed; HFM, hip flexion moment; TSK, Tampa Scale for Kinesiophobia.

Table 4.

Model summary parameters of hierarchical linear regression analysis explaining physical activity (UCLA score) with sex, peak ankle dorsiflexion moment, gait speed, and fear (TSK) in adults with knee OA ($n = 40$).

Dependent variable	Model 1 Independent variables	Standardized beta	t	*P*	sr^2
UCLA score^T	**Step 1**				
	Sex	**0.374**	**2.49**	**0.017**	**0.140**
	Step 2				
	Sex	**0.371**	**2.92**	**0.006**	**0.138**
	Peak Ankle DF moment	−0.205	−0.770	0.446	0.010
	GS	**0.697**	**2.61**	**0.013**	**0.111**
	Step 3				
	Sex	**0.260**	**2.37**	**0.024**	**0.063**
	Peak Ankle DF moment	−0.194	−0.873	0.389	0.009
	GS	**0.533**	**2.36**	**0.024**	**0.063**
	TSK	**−0.474**	**−4.09**	**<0.001**	**0.188**

Note.

^{T}Log transformed. Sex, male = 1. Statistically significant values are in bold.

Abbreviations: DF, dorsiflexion; GS, self-selected gait speed; TSK, Tampa Scale for Kinesiophobia; sr^2, squared semi-parial correlation.

Table 5.

Model summary parameters of hierarchical linear regression analysis explaining physical activity level (UCLA score) with sex, peak hip flexion moment, gait speed, and fear (TSK) in adults with knee OA (*n* = 40).

Dependent variable	Model 1 Independent variables	Standardized beta	t	*P*	sr^2
UCLA score ^{T}	**Step 1**				
	Sex	**0.374**	**2.49**	**0.017**	**0.140**
	Step 2				
	Sex	**0.373**	**2.92**	**0.006**	**0.139**
	Peak Hip FLX moment	0.018	0.093	0.927	0.000
	GS	**0.503**	**2.65**	**0.012**	**0.115**
	Step 3				
	Sex	**0.260**	**2.34**	**0.025**	**0.064**
	Peak Hip FLX moment	−0.003	−0.017	0.987	0.000
	GS	**0.364**	**2.24**	**0.032**	**0.058**
	TSK	**−0.476**	**−4.05**	**< 0.001**	**0.189**

Note.

^{T}Log transformed. Sex, male = 1. Statistically significant values are in bold.

Abbreviations: FLX, flexion; GS, self-selected gait speed; TSK, Tampa Scale for Kinesiophobia; sr^2, squared semi-parial correlation.