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ORIGINAL ARTICLE

Factors associated with self-rated difficulty to descend stairs in persons with knee osteoarthritis

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Abstract

Background: Difficulty descending stairs is common in persons with knee osteoarthritis (OA). Clinically, it is important to know if and how this is explained by objectively measured difficulty to descend stairs, muscle weakness, pain, fear of movement, or knee joint status.
Objective: To identify the potential of these factors to explain self-reported difficulty descending stairs.
Design: Cross sectional, case-control.
Setting: Hospital outpatient and physiotherapy clinic.
Participants: Twenty-eight men and women with knee OA (age 62.2 SD 5.9 years) and 31 controls (age 50.0 SD 8.5 years).
Intervention: Not applicable.
Main outcome measures: Using multivariate statistics, group comparisons were made for lower extremity kinematics (incorporating hip, knee, and ankle angles) and stance time in stair descent and lower extremity muscle strength. Then, a stepwise linear regression analysis was performed within the OA group to explain self-reported difficulties in stair descent where pain, kinesiophobia, radiographic signs, and outcomes that differed from controls for stair-descent kinematics and muscle strength were independent variables.
Results: Multivariate statistics showed that the OA group displayed different all-over lower extremity kinematics ($F_{8,42} = 2.44$ $p = .029$, $\eta^2 = 0.32$) and a longer stance time ($F_{3,50} = 6.46$; $p = .001$, $\eta^2 = 0.28$) in stair descent and lower muscle strength ($F_{7,47} = 2.39$; $p = .035$, $\eta^2 = 0.26$) compared to controls. Regression analysis within the OA group to explain self-rated difficulties to descend stairs showed that the strongest association with kinesiophobia (ß = 0.607, $p = .001$) that combined with pain last week and radiographic signs explained almost 100% (ß = 0.972). Stair descent kinematics and strength variables that differed between groups did not explain self-rated difficulties to descend stairs.
Conclusion: Kinesiophobia and pain rather than stair-descent kinematics and reduced muscle-strength explained self-rated difficulties in stair descent in the OA group.

INTRODUCTION

Osteoarthritis (OA) is the most prevalent joint disease and a leading source of chronic pain and disability in the Western world, where knee OA accounts for about 80% of the total burden.[1] In the United States it affects approximately 19% of the population older than 45 years.[2,3] OA is a biological and biomechanical disease of the joint[4] that affects general fitness and function with consequences for activity and participation.[5] In the early stage, symptoms may be limited and sporadic, but in the later stages they become more severe and extend to a wide spectrum of functional impairments, activity limitations, and participation restrictions.[6] For diagnosing OA, radiography can be used to classify structural status based on the degree of osteophyte formation, joint-space narrowing, and bone sclerosis.[7,8] There is, however, a discrepancy between radiographic findings and clinical symptoms.[5,9] Exemplified in a Swedish cohort aged 56-84 years, radiographically diagnosed knee OA was found in approximately 26% of the cohort whereas symptomatic knee OA was presented by 11% in the same cohort.[10] Consequently, guidelines have been developed for clinical diagnosis,[11] supported by the European League Against Rheumatism (EULAR).[12]

The EULAR guidelines are, according to the International Classification of Function, Disability, and Health (ICF), centered on the level of body structure[12] whereas limitations and restrictions are found on the levels of activity and participation,[13] in particular in advanced stages of disease.[6] Clinical tests should therefore also reflect functional activities in daily life such as gait. There is evidence that persons with knee OA use strategies to reduce joint loading during various gait conditions by generally walking slower and descending stairs with less knee flexion compared to controls.[14-16] Additional findings of increased pelvic motion during stair descent[17] are suggested to reflect compensation for reduced knee flexion in order to reach the next step down and to avoid pain.[18] An inverse association has also been found between pelvic motion and knee extension strength.[17] Reduced knee extension strength, a known predictor for functional decline,[19] is a common finding in knee OA,[20] particularly the ability to produce maximal voluntary eccentric force.[21]

Reduced function in daily life activities in persons with knee OA has been identified with use of a plethora of questionnaires.[22] The importance of stair negotiation is reflected in both the Knee Injury and Osteoarthritis Outcome Score (KOOS) and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), where stair descent is recognized as problematic and thus scored separately. Self-reports indicate difficulties in stair negotiation even in the earlier stages, where knee pain rather than radiographic findings indicates knee OA.[23] Further, fear of movement is a factor that has been shown to predict reduced physical activity,[24] which in turn is likely to lead to reduction in function and muscle strength over time. Notably, stair descent is biomechanically particularly dependent on eccentric strength in quadriceps and triceps surae. Altered kinematics in stair descent[25] and muscle weakness[19-22] are shown to distinguish physical capacity in persons with OA from asymptomatic controls. The strongest discriminator between patients with knee OA and asymptomatic controls appears to be self-reported function, as indicated by the Knee Iinjury and Osteoarthritis Outcome Score (KOOS).[13] One of the KOOS items, A1, scores difficulties in stair descent.

Persons with knee OA often express concerns about difficulties to descend stairs, but the literature is ambiguous about the influence of different explaining factors. Pain and fear of movement are typical, and persons often present with lower extremity muscle weakness and descend stairs in a different manner compared to controls without knee problems. From a clinical perspective it is important to understand which factors may explain the patient's concern. The rationale for this study was to direct the focus toward patient-centered clinical evaluation. The objective was therefore to identify factors potentially associated with self-reported difficulty in stair descent in persons with knee OA. Our hypothesis was that kinematic measurements of stair descent would be strongly associated with self-reported difficulty to descend stairs. In addition, lower extremity strength, pain, kinesiophobia, and radiographically determined joint status would be associated with perceived difficulty to descend stairs.

METHODS

Ethics

The study was performed in accordance with the Helsinki declaration. Written and oral information about the project was provided, and written informed consent was obtained. The project was approved by the regional ethics committee. Some of the data were registered by Infopad,[13] which follows the code of conduct for information security and data protection in the health care and care services.[13,26]

Design

This cross-sectional study is one in a series of a larger project on function with knee OA, comparing patients to knee asymptomatic controls of similar age and gender across the ICF domains, body function—activity—participation. Group differences and background factors were used to assess self-reported difficulty to descend stairs in the OA group. Data were collected in the laboratory at the university in the period November 2016-2017.

Participants

Patients with clinically and radiographically diagnosed uni- or bilateral knee OA according to the Kellgren-Lawrence (KL) scale, meeting the inclusion criteria were invited to the study. Of 36 eligible patients from a hospital physiotherapy outpatient clinic, 26 volunteered to participate and another 2 came from community physiotherapy clinics (total $n = 28$). Control persons without knee symptoms were recruited from a variety of workplaces via advertisement and flyers ($n = 31$). The inclusion criteria were understanding oral and written Norwegian language, aged 45-70 years, and no lower extremity fractures or surgery during last 3 years or neurologic, rheumatic, or orthopedic diagnosis (other than knee OA) potentially influencing strength, gait, and postural control. Participants had to be capable of negotiating stairs without rails, walking step-over-step.

Data acquisition

Stair test protocol

Stair negotiation was tested with a freestanding staircase without railings with three steps on each side of a plateau (dimensions: height 17 cm, tread 40 cm, width 75 cm). Participants walked barefoot up and down step-over-step, across the staircase at their preferred pace four times, alternately starting with the left and right leg.

Kinematic data was collected with an optokinematic motion capture system (Oqus, Qualisys AB, Sweden); with eight cameras (sampling rate 120 Hz). Infrared light was reflected from passive spherical markers (diameter 19 mm) placed on sternum; on sacrum between the posterior superior iliac spines; and bilaterally on acromion, clavicle, crista, anterior superior iliac spine, trochanter, lateral/medial epicondyles, lateral/medial malleoli, lateral/medial foot, similar to the calibrated anatomical systems technique (CAST) model[27] with adapted Helen Hayes model[28] for the pelvic segment. In addition, marker clusters were placed anteriorly on the thighs and shanks to reduce noise from soft tissue movement.

Strength test protocol

Strength tests considered most relevant for the joint angles of interest for stair descent were selected from the Funkart protocol.[29] A 6-minute walk test and 10 step-up and down stair-walk, as part of the greater study, served as a general warmup. The strength tests were performed after the stair test using a Biodex dynamometer linked protocol (Biodex System 4 Dynamometer). Task-specific warmups consisted of 15 light repetitions/condition. The strength tests were performed at 60°/s and included one set of five maximal repetitions/condition. Concentric and eccentric knee extension strength were tested with the dynamometer in "passive mode" to better accommodate the eccentric phase. Concentric strength of triceps surae was tested with ankle plantar flexion in the "isokinetic mode" of the dynamometer. A 30-second rest interval was provided between sets. Biodex has been found to produce valid and reliable mechanical measurements,[30] and similar peak torque measurements have been found between Biodex and Cybex for concentric and eccentric knee flexion/extension.[31] No validation studies were identified for performing maximal strength tests in the "passive mode."

To accommodate task specificity, hip abduction strength was measured with a handheld dynamometer (Commander Muscle Tester, JTech Medical Industries, Midvale, Utah, USA) placed under a nonelastic fixation belt (art. no. 304018, Fysiopartner, Norway) looped around the lateral epicondyle of the femur and secured to a rigid fixture. The person was placed in a supine position with the hip joints oriented in a 0° anatomical position and the pelvis fastened to prevent lateral and inferior sliding.[32] Three maximal isometric repetitions were performed for each side. The less rigid method (no fixed pelvis) has demonstrated reliable measurements for hip strength in healthy individuals,[33,34] cf, Vårbakken et al.[29]

Self-reported measures

Questionnaires were completed at home before entering the test in the laboratory. The OA group competed the full KOOS, and item A1[35] was used to assess self-reported difficulties descending stairs within the knee OA group according to a 5-point Likert scale (0 = no problem, 4 = extreme problems). The questionnaire has been found to have good reliability and content and construct validity for people with menisci and cartilage injuries.[36] Fear of movement was assessed with the Tampa Scale for Kinesiophobia (TSK-13) questionnaire according to a 4-point Likert scale (1 = strongly disagree, 4 = strongly agree),[37] which has shown sound psychometric properties and consistent performance across diverse groups of individuals with OA.[38] Pain was monitored during stair climbing and strength testing and graded with the Numeric Rating Scale (NRS 0-10, none to worst pain).

Analyses

Stair descent

Data were exported from Qualisys Track Manager (Qualisys AB, Gothenburg, Sweden, version 2.2) to Visual3D (v.6.01.10, C-Motion Inc. Germantown, MD, USA) for digital analyses. An eight-segment rigid body model consisting of feet, shanks, thighs, pelvis, and trunk was constructed. A low-pass filter (Butterworth bidirectional cutoff frequency 6 Hz), and interpolation used for gap filling (maximum number of 10 frames) were applied. A virtual marker positioned midway between the medial and lateral forefoot markers was used to identify events (MatLab version 2018b,

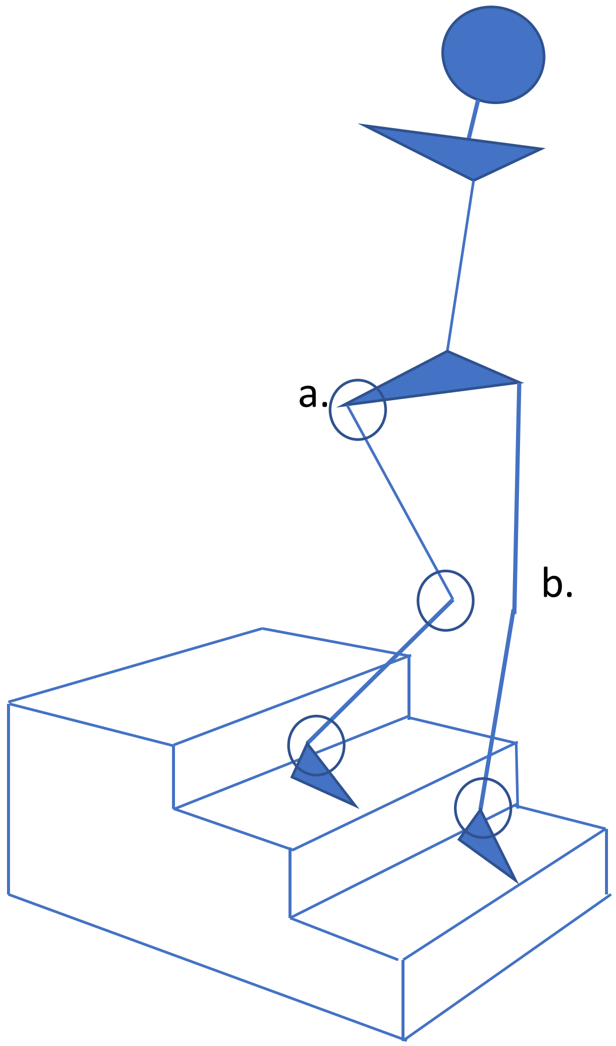

FIGURE 1 Schematic illustration of stair descent at the point in time when the *following leg* (a) is about to leave the tread and the *leading leg* (b) is first touching the next tread. Marked on the figure (circle) are the measured joint angles for the *following leg* (a): hip adduction/abduction, knee flexion, and ankle plantar flexion, and for the *leading leg* (b): ankle plantar flexion. The hip angle is defined with the pelvis as reference where 0° is anatomical position. The knee angle is defined with the femur as reference where the straight knee is 0°. The ankle joint is defined with the shank as reference where 0° is the foot in full plantar flexion and aligned with the shank (neutral standing anatomical position would then be approximately 90°)

The MathWorks, Inc., Natick, Massachusetts, USA). "Toe-down" marked when the *leading* leg (leg b, Figure 1) touched the next step down, defined as the time point when the virtual marker changed direction of movement from forward to backward.[39] "Toe-off" marked when the *following* leg (leg a, Figure 1) left the prior step, defined as the time point when the virtual marker reached its maximum velocity in the upward direction.[40] Kinematic measures were extracted at "toe-down," the time point where maximum knee flexion in the *following leg* during single stance is estimated to occur. Agreement between MatLab-defined events and visually inspected curves and animations in Visual3D were satisfactory. In cases of discrepancy, events were manually corrected in agreement with kinematic curves and motion files.

Variables exported for analyses included duration of single and double stance phases and joint angles for hip abduction/adduction, knee flexion, and ankle dorsi- and plantar flexion. Joint angles and stance phase time were normalized for leg length. The middle step of the second trial of each leg was chosen for analysis.

Muscle strength tests

Strength test data from Biodex were imported into MatLab. A 9-point averaging filter was applied. For the concentric and eccentric knee extension tests, data from the "passive mode" were corrected by adding the torque created by the mass of the leg as the Biodex "passive mode" setting does not automatically include this. Torque curves from a set of the machine moving the relaxed leg was estimated using a polyfit function on the data. Peak torque was extracted for each muscle action and in addition at 65° knee angle for eccentric knee extension strength (representing the approximated peak knee angle in stair descent in the control group). For the ankle test, peak torque concentric plantar flexion was extracted. For hip abduction, isometric peak torques registered by a handheld dynamometer were plotted digitally. The best trial for each test was used and normalized to body weight (Nm/kg), as recommended by Jaric,[41] for further analyses. Data for peak strength measures for concentric knee extension, ankle plantar flexion, and isometric hip abduction are reused from the larger study but include fewer data points owing to incomplete data for some other variables.

Statistical analyses

Sample size calculations for the larger OA project were based on two tails, α error probability $= 0.05$, β error probability $= 0.2$ (power 80%), and a large effect size[42] Cohen's $d = 0.914$ for concentric isokinetic knee extension strength at 60°/s. This required $n = 20$/group but was raised to $n = 30$/group as several other measures were included in the larger project, and a margin for dropouts was calculated.[13,29] The dataset was inspected for missing values and outliers identified by boxplots to determine validity of extreme measurements. Normal distribution was confirmed by group and leg with QQ-plots and Kolmogorov-Smirnov or Shapiro-Wilk. Homoscedasticity was assessed by residual plots. A general linear model (GLM) was used to assess groups differences. Age and body mass index were included as covariates in the models for leg-length normalized stair descent variables (joint angles and stance phase duration) and age for weight-normalized muscle strength variables. The most affected side in the OA group was compared to the nondominant side in the control group, and the least affected side in the OA group was compared to the dominant side in controls. This choice was motivated by the fact that the dominant side has better motor control and is often stronger; thus the nondominant side is a better match with the most affected side in the OA group. A multivariate test with *n* variables for each domain assessed the effect of group with Wilks' Lambda for joint angles ($n = 8$), stance phase duration ($n = 3$), and muscle strength ($n = 7$). Post hoc univariate tests were used to assess group differences within each of these domains. For the purpose of entering factors into the regression model, Spearman's rho (0.20-0.39 weak; 0.40-0.59 moderate; 0.60-0.79 strong; 0.80-1.0 very strong) was applied to assess correlations within the OA group for pain intensity (NRS) last week and in stair descent test, duration (years) of pain, and time (years) since diagnosis, radiography, self-reported difficulties in stair descent (KOOS), and kinesiophobia (TSK), together with kinematic stair descent and muscle strength variables that differed between groups. Factors in the order of correlational strength with self-reported difficulties in stair descent were then entered into a stepwise linear regression model to detect predictive value. Curve fit analysis was used to assess linearity. Multicollinearity was accounted for in the regression model by variance inflation level (VIF) excluding factors violating the rule. Effect-size was considered with partial eta squared ([η2], small 0.01, moderate 0.06, large 0.14) and the level of significance was set at $p < .050$. All statistical analyses were carried out in SPSS version 26 (IBM, Armonk, New York, USA).

RESULTS

The number of participants was adjusted for missing data: in the OA group, unable to descend stairs "step-over-step" ($n = 1$) and unsatisfactory kinematic quality ($n = 2$); in the control group, failed eccentric strength measurement ($n = 1$) and unsatisfactory kinematic quality ($n = 2$).

Characteristics

The groups were successfully matched except for age; the OA group was significantly older. The mean time since OA diagnosis was 11.2 years and more than 50% had experienced knee pain for more than 10 years with moderate pain during the last week. TSK revealed mild fear of movement, injury, and pain, whereas KOOS showed a rather high level of self-rated difficulties in stair descent. The majority had KL grade III showing moderate joint degeneration in the most affected knee, whereas about 50% had none, and 50% mild to moderate radiographic signs of OA in the least affected knee (Table 1).

Stair descent: group differences

The overall between-group-difference showed that the kinematic pattern was different in the OA group ($F_{8,42} = 2.444$; $p = .029$, $\eta^2 = 0.32$). The largest differences were found for the most affected leg in the OA group compared to the nondominant leg in the control group, where hip adduction was larger in the OA group ($F_{1,49}$

TABLE 1 Characteristics of the groups (means and SD)

Variables	Knee OA ($n = 28$)	Controls ($n = 31$)	*p* value
Female, *n* (%)	17 (68)	16 (57)	.329
Age (years)	62.2 (5.9)	50.0 (8.5)	**.001*** **
BMI, kg/m^2	27.8 (4.1)	26.5 (2.3)	.269
Leg length (m)[a]	0.91 (0.06)	0.88 (0.04)	.923
Leg length (m)[b]	0.91 (0.06)	0.87 (0.03)	.908
Years since diagnosis	11.2 (8.2)	n/a	
Years of knee pain, *n* (%)[c]			
1	1 (4)	0	
1 to 3	3 (12)	0	
3 to 10	7 (28)	0	
>10	14 (56)	0	
Average pain last week (NRS)[d]	4.3 (2.3)	0.0 (1.0)	
TSK Fear of movement	24.4 (7.7)	n/a	
KOOS stair descent (item A1)	4.3 (2.3)	n/a	
Radiography grade, *n* knees, (%)[e]	Leg[a]/leg[b]	n/a	
Without radiography	0 [0]/11 [40]	n/a	
KL grade II	8 [30]/8 [30]	n/a	
KL grade III	17 [63]/8 [30]	n/a	
KL grade IV	2 [7]/0 [0]	n/a	

Abbreviations: BMI, body mass index; KL grade, Kellgren-Lawrence osteoarthritis grade (0 = no radiologic signs, IV = severe OA); KOOS, Knee Injury and Osteoarthritis Outcome Score, 5-point Likert scale (0 = no problem, 4 = extreme problems, scale adjusted to 1-5 for statistical purpose); NRS, Numerical Rating Scale (none to worst pain 0–10); OA, osteoarthritis; TSK, Tampa Scale for Kinesiophobia, 13 items, Likert scale (1 = strongly disagree, 4 = strongly agree). Score: 13-22 subclinical, 23-32 mild, 33-42 moderate, and 43-52 severe; Without radiography, 0 = all most affected knees had radiography, 11 = eleven least affected knees had no radiography.
[a]Most affected in OA group/nondominant in control group.
[b]Least affected in OA group/dominant in control group.
[c]Information about pain missing $n = 3$.
[d]Statistics not tested because control reports no pain.
[e]Radiography missing $n = 1$.
Statistically significant: .05*; .01**; .001***

$= 8.423$; $p = .006$, $\eta^2 = 0.15$). The other joint angles did not differ significantly between groups (Figure 1, Table 2).

Stance phase durations were generally longer in the OA group ($F_{3,50} = 6.46$; $p = .001$, $\eta^2 = 0.28$). The difference was largest for double stance ($F_{1,52} = 19.879$; $p < .001$, $\eta^2 = 0.28$), whereas single stance duration did not differ significantly between groups (Table 2).

Muscle strength: group differences

The overall between-group comparison revealed lower muscle strength in the OA group ($F_{7,47} = 2.39$; $p = .035$, $\eta^2 = 0.26$). Univariate analyses showed that only concentric knee extension strength in the most affected side was significantly lower in the OA group ($F_{1,53} = 7.770$; $p = .007$, $\eta^2 = 0.13$). Pain (NRS) during strength testing in the OA group was 2.4 (SD 2.5) for concentric knee extension and 1.4 (SD 2.3) for ankle plantar flexion. For all other tests, no pain (<1) was reported for both groups.

Factors associated with self-reported difficulties in stair descent: OA group

A stepwise regression analysis was used to find factors explaining self-reported difficulties to descend stairs. Spearman's rho was used to assess the correlational

TABLE 2 Group differences for joint angles in stair descent and muscle strength test (means and SD)

Stair descent controlled for age and BMI	Variables	Knee OA ($n = 25$)[a]	Controls ($n = 28$)[a]	p value	95% CI
Joint angles, leg length normalized (°)					
Following leg					
Most affected/nondominant	Ankle[b] dorsiflexion	116.1 (14.6)	109.4 (9.8)	.207	-2.7, 12.1
	Knee flexion	65.0 (10.4)	72.7 (13.0)	.061	-13.7, 0.3
	Hip adduction	7.4 (4.4)	1.3 (6.4)	**.006****	1.4, 7.8
Least affected/dominant	Ankle[b] dorsiflexion	115.7 (15.5)	110.4 (10.1)	.333	-4.0, 11.7
	Knee flexion	71.3 (10.1)	74.1(12.6)	.511	−9.2, 4.6
	Hip adduction	4.6 (5.4)	3.6 (5.9)	.936	−3.2, 3.5
Leading leg					
Most affected/non-dominant	Ankle[b] plantar flexion	60.5 (8.6)	63.4 (7.9)	.143	−8,5, 1.3
Least affected/dominant	Ankle[b] plantar flexion	60.4 (8.5)	63.6 (8.0)	.108	−8.9, 0.9
Stance phases, leg length normalized (s) Controlled for age and BMI					
Most affected/nondominant	Single support	0.47 (0.09)	0.39 (0.09)	.064	−0.0, 0.1
Least affected/dominant	Single support	0.43 (0.17)	0.41 (0.04)	.454	−.05, 0.1
	Double support	0.14 (0.05)	0.07 (0.04)	**<.001**[c]***	0.0, 0.1
Muscle strength Weight normalized Controlled for age					
Most affected/non-dominant	Knee ext. ecc. 65°	1.1 (0.4)	1.2 (0.3)	.171	−0.3, 0.1
	Knee ext. conc.	1.5 (0.5)	2.0 (0.5)	**.007****	**−0.7, −0.1**
	Hip abduction	0.9 (0.3)	1.0 (0.3)	.500	−0.3, 0.1
	Ankle[b] plantar flexion	0.6 (0.2)	0.8 (0.2)	.056	−0.3, 0.0
Least affected/dominant	Knee ext. ecc. 65°	1.2 (0.4)	1.4 (0.3)	.201	−0.4, 0.1
	Knee ext. conc.	1.8 (0.5)	2.0 (0.7)	.526	−0.5, 0.2
	Hip abduction	0.9 (0.4)	1.0 (0.3)	.286	−0.3, 0.1
	Ankle plantar flexion	0.6 (0.3)	0.8 (0.2)	.391	−0.2, 0.1

Note: Joint angles in stair descent: knee joint angle degrees/leg length. Stance phase in stair descent: stance time (s)/leg length. Muscle strength tests: Nm/body weight (kg).

Abbreviations: BMI, body mass index; Conc, concentric muscle strength; Ecc, eccentric muscle strength; OA, osteoarthritis.

[a]Excluded because unable to perform stair test (OA $n = 1$), missing owing to unsatisfactory kinematics (OA $n = 2$, Control $n = 2$), failed eccentric knee strength test (Control $n = 1$).

[b]Ankle joint angle: 0° for ankle = maximum possible plantar flexion dorsum in line with shank. i.e. vertical.

[c]p<.001.

Statistically significant: .05*; .01**; .001*** strength of factors for the purpose of entering these in due order into the regression analysis. Table 3 shows the factors significantly correlating with KOOS, which were entered into the linear regression model in a stepwise fashion according to order of correlational strength. The first model excluded all variables but TSK, which was the strongest singular predictor and kept in all three models. The second model included pain last week as the next strongest predictor. The third model, which in addition included radiography, showed total predictive value close to 1. Radiography alone did however not have any significant predictive value (Table 4).

TABLE 3 Factors tested for correlation with self-rated difficulties in stair descent (KOOS) within the OA group to investigate correlational strength for order of entering into the stepwise regression model

Factors differing between the OA and control group	Correlation R	*p* value
Stair descent kinematics, joint angles ($n = 25$)[a]		
Hip adduction in the following leg, most affected leg	0.25	.213
Stance phase duration ($n = 27$)[a]		
Double support	0.29	.142
Strength ($n = 27$)[a]		
Concentric knee extension. Most affected leg	- 0.27	.180
Self-reported factors ($n = 27$)[a]		
Pain last week (NRS)	0.59	**.001***
Pain during stair descent (NRS)	0.54	**.004**
Kinesiophobia. Tampa scale (TSK)	0.53	**.005**
Pain duration (years)	0.41	**.033***
Radiographic findings (KL)	0.38	**.049***

Note: Joint angles and stance time normalized to leg length; strength normalized to body weight. Spearman's rho: 0.20-0.39 weak; 0.40-0.59 moderate; 0.60-0.79 strong; 0.80-1.0 very strong.

Abbreviations: KL, Kellgren-Lawrence osteoarthritis grade (0 = no signs, IV = severe signs); KOOS, Self-rated difficulties in stair descent according to Knee Injury and Osteoarthritis Outcome Score, item A1: A 5-point Likert scale (0 = no problem. 4 = extreme problems); NRS, Numerical Rating Scale (0 = no pain, 10 = worst pain); OA, osteoarthritis; TSK, Tampa Scale for Kinesiophobia 13 items, Likert scale (1 = strongly disagree, 4 = strongly agree). Score: 13-22 subclinical, 23-32 mild, 33-42 moderate, and 43-52 severe.

[a]Excluded because unable to perform stair test "step-over-step" ($n = 1$), missing owing to unsatisfactory kinematics ($n = 2$).

Statistically significant: .05*; .01**; .001***

DISCUSSION

The study objective was to identify factors potentially explaining the level of self-reported difficulty in stair descent in persons with knee OA. Our results showed that self-reported difficulty in stair descent was associated with kinesiophobia and pain last week, rather than differences from controls in manner of stair descent (longer double stance duration and larger hip adduction) or lower muscle strength (concentric knee extension). Our hypothesis that kinematic measurements of stair descent would be strongly associated with self-reported difficulty to descend stairs was thus rejected, and association with other factors only partly supported.

Our results agree with others about the importance of taking kinesiophobia and fear of pain serious in patients with knee OA. Pain catastrophizing has shown to predict worse self-rated stair negotiation performance[43] and explains a significant proportion of psychological matters as well as physical function,[44] additionally being a contributing factor to greater perceived pain in physical activity in persons with knee OA.[45] Catastrophizing is in general conceived as an exaggerated negative "mental set," known to contribute

TABLE 4 Independent variables predicting self-reported difficulty to descend stairs (KOOS) in the OA group. Factors from Table 3 were entered in order to correlational strength into a stepwise linear regression model. The model excluded variables violating multicollinearity. Variance inflation level (VIF) for included factors <2

Independent variable	B	SE B	ß	t	*p* value	95% CI for B
Model 1						
Kinesiophobia (Tampa scale, TSK)	0.10	0.02	0.61	30.82	.001	0.04, 0.15
Model 2						
Kinesiophobia (Tampa scale, TSK)	0.08	0.02	0.49	30.22	.004	0.03, 0.13
Pain last week (NRS)	0.20	0.08	0.38	20.54	.018	0.04, 0.36
Model 3						
Kinesiophobia (Tampa scale, TSK)	0.07	0.02	0.44	20.84	.009	0.02, 0.12
Pain last week (NRS)	0.19	0.08	0.37	20.42	.024	0.03, 0.36
Radiographic findings (KL)	0.34	0.32	0.16	10.05	.306	−0.33, 1.0

Abbreviations: B, unstandardized coefficient; CI, confidence interval; KL, Kellgren-Lawrence osteoarthritis grade (0 = no signs, IV = severe signs); KOOS, Self-rated difficulties in stair descent according to Knee Injury and Osteoarthritis Outcome Score, item A1: A 5-point Likert scale (0 = no problem. 4 = extreme problems); NRS, Numerical Rating Scale (0 = no pain, 10 = worst pain); OA, osteoarthritis; *SE* B, the SE of B; ß, standardized coefficient; TSK, Tampa Scale for Kinesiophobia 13 items, Likert scale (1 = strongly disagree, 4 = strongly agree). Score: 13-22 subclinical, 23-32 mild, 33-42 moderate, and 43-52 severe.

to intensify pain.[46] Authors thus recommend that clinicians include assessment of pain catastrophizing in the clinical examination.[44]

Radiologic findings were associated only weakly but still found to contribute to explaining self-reported difficulties in stair descent. This finding is in line with that of others who found that (perceived) function and pain rather than radiographic findings indicate (symptomatic) knee OA.[23] Still, self-rated function seems to discriminate between mild and severe radiographically determined joint deterioration.[47] It is thus recommended that self-rated function together with radiographic examination be used in the clinical assessment of osteoarthritis.[48]

In the present study, we expected that differences from controls in manner of stair descent and muscle strength would correlate with the KOOS score and thus explain self-reported difficulty in stair descent. No such correlations were found. The kinematic findings are, however, in line with findings by Grenholm et al[39] and Hicks-Little et al[14] who reported similar outcomes for the same joints and point in time during stair descent. Grenholm and colleagues considered patellofemoral pain in young females and Hicks-Little et al investigated stair descent in knee OA. Both conditions are characterized by knee pain and the manner of stair descent suggests strategies to decrease loading of the knee joint presumably to avoid pain. These studies did not, however, investigate the influence of pain on kinematics. In our study, pain during the stair descent test was negligible and did not correlate with the manner of stair descent but did, however, correlate with self-reported difficulties to descend stairs. In the regression model, pain in stair descent was excluded because of multicollinearity between pain measures. Our results also showed 7° less knee flexion in the OA group compared to controls, albeit not statistically significant. Similar findings have been presented in studies where an inverse relationship between reduced knee extension strength and larger hip motion has been demonstrated,[17] suggesting compensation for reduced knee extension strength. Smaller knee flexion angle was an expected effect of reduced knee extensor strength and/or to reduce knee joint loading to avoid pain. Another sign that can be interpreted as an attempt to reduce knee joint loading is longer stance phase duration, suggesting reduced gait velocity. Longer stance phases in stair negotiation have been supported in several studies, one demonstrating that patients with knee OA spent 18% of the total gait cycle in double support, compared to 11% in the control group.[16,49-51] Studies have also found that lower gait velocity seems to be associated with greater knee adduction moments and increasing varus malalignment, showing stronger association with increasing radiologic OA severity[52] whereas others have not supported such associations.[53] Biomechanically, reduced gait velocity and reduced knee flexion angle in combination will reduce the moment across the knee joint. In stair descent, this will reduce the impact of the knee contact forces[54] and thus probably also pain. The manner of stair descent does thus not seem to describe a problem but maybe rather a solution not related to current perceived difficulty in stair descent.

Eccentric knee extension strength did not differ between groups, in contrast to what was expected considering results from previous studies[21] and from evidence of reduced knee flexion in stair descent.[14-16] An explanation might be that most study participants found this task very difficult to perform in the Biodex machine. One control person was excluded owing to not being able to perform this task.

LIMITATIONS

The interpretation of our results needs to be made in the light of some considerations. The OA group was older, and age therefore controlled for. The effect of age was, however, not significant in the multivariate test ($F_{8,42} = 1347$; $p = .248$, $\eta^2 = 0.24$). Our choice of point in time and variables in stair descent and strength tests were carefully selected to accommodate knee joint loading in stair descent but does not guarantee that other factors may have given other results. Greater weakness found in ankle eversion and hip external and internal rotation[29] were not considered, as they do not act as prime movers of the joint angles of interest. Eccentric hip abduction and plantar flexion strength tests to better accommodate task specificity were not performed. Finally, KOOS item 1A does not specify the type of difficulties in stair descent, which may differ between participants. Self-selected gait-velocity was considered a strength as the purpose of the study was to observe the natural gait pattern. Potential insecurity during performance of the stair test could not have influenced any of the self-rated items, as questionnaires were completed at home before entering the test situation in the lab. The internal validity was considered satisfactory, whereas external validity is limited to those high functioning, that is, able to descend stairs without rails in a "step-over-step" manner. External validity may also be affected by the difference between lab-test and real-life situations where a three-step stair module does not capture stair descent as a whole but is influenced by start of descent.

CONCLUSION

Our results revealed that self-reported difficulty in stair descent was explained by kinesiophobia and pain in the previous week, rather than differences from controls in manner of stair descent or muscle strength. The results also showed that radiographic signs of OA play a minor role. Patients' perceptions should therefore be seriously considered even if they do not match results of functional tests and radiographic findings.

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DISCLOSURES

The authors declare that they have no disclosures.

ETHICS APPROVAL

Participants received verbal and written information and a signed a consent of participation was obtained from each participant according to the declaration of Helsinki. The project is part of the Funkart study and was approved by regional ethics committee [2016/984/REK nord (2016/08.06)]. Some of the data were registered by Infopad, which follows the Norwegian code of conduct for information security and data protection in the health care and care service. All data were anonymized and stored in a designated area on the university server.

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