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Could Activity Modifications Indicate Physical Decline among Adults with Symptomatic Knee Osteoarthritis?

Augustine C. Lee, MD[1], **Rina M. Bloch, MD**[2], **William F. Harvey, MD, MSc**[1], **Jeffrey B. Driban, PhD, ATC, CSCS**[1], **Lori Lyn Price, MAS, MLA**[3,4], **Xingyi Han, MPH**[1], and **Chenchen Wang, MD, MSc**[1]

[1]Center for Complementary and Integrative Medicine, Division of Rheumatology, Tufts Medical Center, Boston, MA, USA

[2]Department of Physical Medicine and Rehabilitation, Tufts Medical Center, Boston, MA, USA

[3]Institute for Clinical Research and Health Policy Studies, Tufts Medical Center, Boston, MA, USA

[4]Tufts Clinical and Translational Science Institute, Tufts University, Boston, MA, USA

Abstract

Objectives—Mobility activity modifications indicate early functional losses that act as precursors to future declines among community-dwelling older adults. However, there is scarce evidence on whether activity modifications indicate poorer physical health among adults with symptomatic osteoarthritis, a major cause of disability. Our purpose was to investigate if patient-reported mobility activity modifications indicated poorer physical health among adults with symptomatic knee osteoarthritis.

Design—Secondary cross-sectional analysis of randomized trial data. Pre-Clinical Disability Questionnaire was used to group participants into 3 categories: difficulty, modified, and no difficulty walking/stair-climbing. Kruskal Wallis and chi-square tests were used to compare clinical factors across groups.

Results—Among 121 participants (median age: 60 years; 73% female; 60% white), <10% had modified walking/stair-climbing. Compared to those with no walking difficulty, participants with modified walking had significantly less balance (p=0.01) and global health (p=0.01), and greater knee pain (p=0.05) and physical disability (p=0.04). Those with modified stair-climbing had significantly smaller walking distances (p=0.03) compared to those with no difficulty stair-climbing.

Corresponding Author: Chenchen Wang, MD, MSc, Center for Complementary and Integrative Medicine, Division of Rheumatology, Tufts Medical Center, 800 Washington Street, Box 406, Boston, MA, 02111, Phone: 617-636-3251, Fax: 617-636-1542, CWang2@Tuftsmedicalcenter.org.

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Conclusion—Activity modifications may signal early impairments in physical health among people with symptomatic knee osteoarthritis. If confirmed, patient-reported activity modifications may enhance symptom evaluation in osteoarthritis and enable a better understanding of the disablement process.

Keywords

Knee Osteoarthritis; Activities of Daily Living; Mobility Limitations; Symptom Evaluation

INTRODUCTION

Knee osteoarthritis (OA) is a leading cause of disability worldwide, and symptoms are estimated to develop in one out of every two adults in their lifetime[1]. Characterized by progressive functional decline, knee OA can particularly limit mobility activities (i.e. walking and climbing stairs) among older adults[2]. Despite its high prevalence and societal burden, little is known about the specific progression of disability in this patient population[3].

Symptom assessment of adults with knee OA relies upon both patient-report and physical performance-based instruments[4]. However, these measures typically do not fully account for modification strategies of physical activity made in daily life. An emerging body of gerontological research shows that, despite early physical impairments, older adults are able to use activity modifications to accomplish tasks without perceiving limitations[5]. Activity modifications are adaptations that individuals use to cope with detrimental changes in body structure or function in an effort to maintain physical activity and participation levels[5]. Examples of modifications can range from overt (e.g. walking with an altered gait to avoid discomfort) to subtle (e.g. holding a handrail to climb stairs). These activity modifications are important because they may indicate early, slight losses in health that are precursors to future decline. Indeed, among community-dwelling older adults, mobility modifications predicted the onset of task difficulty, hospitalizations, mobility limitations, and future falls[6–11].

Among participants with OA, however, empirical evidence on the utility of activity modifications to indicate poorer health is scarce. Concerns that activity modifications may confound patient-reported symptom levels have been previously documented in OA research[12]. Yet, only one study has examined how perceived activity modifications were associated with health outcomes among this patient population[13]. Gignac *et al.* found that modifications were associated with age and mobility difficulties among patients with various types of OA. However, this study only included participants with established activity difficulty and did not utilize a validated questionnaire to ascertain modification behaviors. Therefore, it remains unknown whether patient-reported activity modifications could be used to indicate early declines in physical health, i.e. poorer health among patients with no mobility difficulty. In addition, no prior study has examined activity modifications specifically among participants with knee OA.

Therefore, the purpose of this investigation was to explore if patient-reported activity modifications indicated poorer physical health among adults with symptomatic, radiographic knee OA. Specifically, we compared those who utilize mobility modifications with those

who do not. We hypothesized that participants who modified their walking/stair-climbing would have poorer physical health than those with no walking/stair-climbing difficulty. Because activity modifications may identify a transitional state on the continuum of disablement, the results from this study may help to enhance the evaluation of symptoms and the understanding of disablement in knee OA.

METHODS

Study design and Participants

This was a cross-sectional study of participants from a 52-week single-blind, randomized trial comparing 12-week Tai Chi and Physical Therapy interventions for symptomatic radiographic knee OA (Trial Registry #NCT01258985). A detailed description of the methodology and primary study results for this trial has been previously published[14,15].

Study inclusion criteria for the parent trial were: 1) age ≥ 40 years, 2) fulfillment of the American College of Rheumatology criteria for knee OA, and 3) Western Ontario and McMaster Osteoarthritis Index (WOMAC) pain score ≥ 40 for at least 1 of 5 questions (score range 0–100 for each question). Exclusion criteria included: 1) prior experience with complementary medicine or Physical Therapy programs for knee OA within the past year, 2) severe medical limitations precluding full participation, 3) intra-articular steroid injections or surgery in the past three months, 4) intra-articular hyaluronic acid injections in the past six months, 5) Mini-Mental Status examination score <24, or 6) inability to walk without an assistive device.

Participants were randomly assigned in a 1:1 ratio to Tai Chi or Physical Therapy. The research study nurses and physical function assessors were blinded to the treatment assignments, and the blinded assessors did not have access to the data until data collection was complete. All participants signed an informed consent form before enrollment that covered the use of obtained data in secondary analyses. The study, including this investigation, was approved by the Tufts University/Tufts Medical Center Institutional Review Board.

The participants included in the present investigation were those who had data on activity modifications at the 52-week visit. Self-reported data on activity modifications was collected in the parent trial after subject recruitment and data collection had already begun. Therefore, this investigation analyzed data from the 52-week follow-up visit of the parent trial in order to maximize the available number of participants categorized as using modified mobility activities. In addition, because both interventions had similar results in pain, function, and other health outcomes at 52-weeks, participants from treatment groups were combined for this cross-sectional analysis. This study conforms to all STROBE guidelines and reports the required information accordingly (see Supplementary Checklist).

Outcome Measures

Mobility Activity Modifications—The *Pre-Clinical Disability Questionnaire* is a 12-item patient-reported measure of current mobility activity modifications. This instrument is made up of a series of 6 yes/no task-specific questions about changing the method of performing

daily mobility activities (vigorous activities, walking long distances, climbing one flight of stairs, lifting groceries, bending/kneeling/stooping, and getting in/out of cars) and another corresponding 6 questions about changing the frequency of performing these activities. This questionnaire is intended to be used in conjunction with other, widely-used physical function questionnaires, such as the Short Form-36 Physical Function subscale, to categorize participants into subgroups based on their activity limitations and corresponding use of modification strategies. Construct validity and reliability properties of this instrument have been found among community-dwelling older adults[10].

Patient-Reported Outcomes—A validated self-reported questionnaire with a 48-hour recall period, the *WOMAC (v.3.1, visual analog)* consists of 3 subscales: pain intensity, stiffness, and physical function in patients with knee OA[16]. The pain subscale, which ranges from 0-500mm, consists of 5 items asking about pain during rest or activity. The stiffness subscale, which ranges from 0–200mm, consists of 2 items asking about the degree of stiffness in the affected joint. The physical function subscale, which ranges from 0–1700mm, consists of 17 items asking about ability to perform daily activities. Higher scores indicate greater pain or stiffness, and poorer physical function, respectively.

A single, 0–10cm visual analog scale item, the *Patient Global Assessment* is a validated measure of the patient global health by asking “Considering all the ways your knee OA affects you, how are you doing today?” Higher score indicates poorer global health.[17]

A generic measure of health-related quality of life, the *Short Form-36 (SF-36)* has well-validated psychometric properties and consists of 36 questions related to eight dimensions of health[18]. Raw scores are transformed into a point scale ranging from 0 to 100, with higher scores indicating better perceived health status. To avoid information duplicative of other outcome measures used in this analysis, only items from the Physical Function subscale were used in conjunction with the Pre-Clinical Disability Questionnaire.

Physical Performance Outcomes—The *20-Meter Walk Test* is a validated physical performance test of gait speed at usual pace. Initially measured in seconds, data were converted to meters per second to facilitate interpretability[19]. Thus, higher meters per second values indicate faster gait speed and better performance.

The *Six-minute Walk Test* measures walk ability and endurance and is widely used to assess submaximal level of functional performance at levels typically required for daily physical acitivities[20]. Participants are asked to walk as far as possible within a six-minute period, and the resulting distance is recorded. Both walking tests were performed in quiet hallways and were administered by trained investigators following a standard script.

The 10-repetition *Chair Stand Test* measures the ability to rise from a chair, sit back down, as well as lower body strength and power[20]. Measured as the total number of seconds required to complete 10 repetitions, lower scores indicate better performance.

The Berg Balance Scale is a validated performance-based test of static and dynamic balance, including the performance of 14 functional tasks such as standing from a seated position,

standing unsupported for two minutes, turning 360°, and standing on one foot[21]. Berg scores range from 0 to 56 with higher scores indicating better balance.

Leg extensor muscle strength was assessed according to bilateral leg press apparatus using the one-repetition maximum (1RM) technique. *Leg extensor peak muscle power and peak contraction velocities were* made after a 5-minute rest period. Briefly, each participant was instructed to complete a total of 5 repetitions, each separated by 30 seconds, as quickly as possible through their full range of motion at 40% and then at 70% of the 1RM. The highest measured power output and corresponding contraction velocity elicited at 40% and 70% of the 1RM were recorded as the respective measures of peak muscle power and peak contraction velocity. Further details about these evaluations have been previously published[22].

Procedure—Participants were divided into functional mobility categories according to the Pre-Clinical Disability Questionnaire and items from the SF-36 using the approach developed by Fried and colleagues[8,23] (See Figure 1). Using items from the SF-36 Physical Function subscale, participants were asked to report any current difficulty (Yes, limited a lot or a little; or No, not limited at all) while performing two mobility tasks: walking more than a mile or climbing a flight of stairs. Those who had difficulty with performing the task (either a little or a lot) were categorized as “Difficulty Walking/Stair-Climbing”. Among those who did not have task difficulty, we used responses from two follow-up questions from the Pre-Clinical Disability Questionnaire to further subcategorize participants based on use of activity modifications: “Due to underlying health problems, have you changed the way or decreased how often you (walk more than a mile; or climb a flight of stairs)?” Hence, those who did not have difficulty with task performance but modified their method or frequency were categorized as “Modified Walking/Stair-Climbing”; which is referred to as “Pre-clinical Disability” in other studies[8,23]. Conversely, those with no task difficulty and no modification of walking/stair-climbing were categorized as “No Difficulty Walking/Stair-Climbing”; which is referred to as “Robust Mobility” in other studies[8,23].

Statistical Analysis

Descriptive statistics were computed for all variables and presented as number (%) or median (25th, 75th percentiles). Due to skewed distributions of participants (determined via Shapiro-Wilk test) among the 3 subgroups of functional mobility (i.e. ‘difficulty’, ‘modified function’, and ‘no difficulty’), non-parametric Kruskal Wallis tests were used to compare continuous subgroup demographic and clinical characteristics. The chi-square or Fisher’s exact tests (where appropriate) were used to compare categorical characteristics. The global test was performed first. If the results were statistically significant, then all pairwise comparisons were performed. Significance level was $p \leq 0.05$, and all data were analyzed using SAS statistical software (Version 9.4). Because this investigation was hypothesis-generating in nature, analyses were not adjusted for multiple comparisons.

RESULTS

Table 1 summarizes the baseline demographic and clinical characteristics of all 121 participants with walking activity data. The participants were predominantly female (73%),

well-educated (83% with some post-secondary education), and white (60%) with median age of 60 (53, 68) years and body mass index (BMI) of 31.4 kg/m^2. The demographic and clinical characteristics of the 106 participants with stair-climbing activity data were similar (data not shown).

Among the 121 participants with walking activity data, 27 (22.3%) had no difficulty walking, 9 (7.4%) had modified walking, and 85 (69.7%) had difficulty walking (Table 2). Compared to those with no difficulty walking, participants with modified walking had significantly poorer balance (p= 0.01) and global health (p= 0.01); and significantly greater pain (p= 0.05), physical disability (p= 0.05), and stiffness (p= 0.01). No other significant differences were found between those with no difficulty walking and those with modified walking. The only significant differences between the difficulty walking and modified walking groups were that the modified walking group had poorer balance (p= 0.01).

Among the 106 participants with stair-climbing activity data, 28 (26.4%) had no difficulty stair-climbing, 9 (8.5%) had modified stair-climbing, and 69 (65.1%) had difficulty stair-climbing (Table 3). Compared to those with no difficulty stair-climbing, participants with modified stair-climbing had a significantly shorter 6-minute walk distance (p=0.03). In addition, the modified stair-climbing group had poorer physical functioning (p=0.12), global health (p=0.08), and gait speed (p=0.08) that were marginally significant. No other significant differences were found between those with no difficulty stair-climbing and those with modified stair-climbing. The only significant differences between those with difficulty stair-climbing and those with modified stair-climbing were that the modified stair-climbing group had less males (p=0.05).

For graphical representation of these results, see Supplemental Figures 1–4.

DISCUSSION

This study investigated the utility of self-reported activity modifications to indicate physical health decline among adults with symptomatic, radiographic knee OA. Despite having no perceived difficulty walking, participants who modified their walking had significantly poorer pain, function, global health, and stiffness compared to those with no walking limitation. The magnitudes of difference for pain, function, and global health were clinically meaningful[24]. Similarly, participants who modified their stair-climbing had poorer walk distance, function, and global health compared to those with no stair-climbing modifications; albeit marginally significantly. The magnitudes of difference for walk distance, function, and gait speed were clinically meaningful[20,24,25]. Notably, only a small percentage of participants (<10%) of our sample were categorized with modifications. To our knowledge, this is the first empirical evidence supporting the notion that activity modifications may influence symptom levels among adults with knee OA.

These findings are concordant with the results of Gignac et al., which examined how modifications were associated with health outcomes specifically among an OA group with manifest activity difficulty[13]. Our study expands this field by showing that walking/stair-climbing modifications may indicate poorer physical health among adults with symptomatic

knee OA who have not yet developed manifest difficulty. Hence, modifications may indicate an early, intermediate phase of physical decline. Our results are also concordant with similar findings among community-dwelling older adults that showed that activity modifications were associated with poorer physical function[6,10,23] and balance[23]. Given the small sample sizes of participants with modified mobility activity, it is difficult to draw inferences from the non-significant findings of our results. However, our findings were discordant with prior studies that found significant associations between activity modifications and various performance-based measures, including gait speed, chair-stand test, and lower extremity strength among community-dwelling older adults[8,10,23,26,27]. From our results, a pattern was observed wherein the modified walking group had significantly poorer physical health according to patient-reported rather than physical performance-based outcomes. This may, in part, reflect the substantial body of evidence showing that patient-reported and physical performance-based measures provide distinct, but complementary information among patients with OA[28]. However, the stair-climbing groups in our study had marginally significantly poorer physical health according to both patient-reported and physical performance-based outcomes. Thus, disparate patterns of association based on patient-reported versus performance-based measures may vary by activity type.

The primary implication of these findings for researchers is that activity modifications may influence perceived physical symptoms, which has been widely suspected among patients with knee OA[12]. Because symptomatic assessments are a central component of the knee OA clinical research paradigm, a greater awareness of how to optimally account for modifications in research methodology may be needed. Another implication of this study is the unexpectedly low prevalence of participants categorized with modified walking/stair-climbing. While the prevalence of using activity modifications was previously found to be ≈20–25% among community-dwelling older adults[6–11,23], it may be that the <10% prevalence found in this study is explained by the younger age of our participants (≈61 years old) relative to those found among older adults (≈70–77 years old). This discordance may also result from the relatively strict inclusion/exclusion criteria of the parent trial: only participants with both symptomatic and radiographic evidence of disease were included; and people unable to walk without an assistive device were excluded. However, it is unknown whether the low prevalence found in our study can be generalizable to other knee OA clinical trial populations or the larger patient population as a whole. If strictly generalizable to clinical trial participants, patients who use modifications may be underrepresented in OA clinical trials. Therefore, examination among both clinical trial and non-clinical trial samples are needed for clarification. If confirmed, less stringent inclusion criteria may be necessary to appropriately investigate this patient subgroup in the clinical trial setting. Another possibility may be that the Pre-Clinical Disability Questionnaire does not optimally identify people who use activity modifications in this patient population. As an example, it may be helpful to capture gradations of modification strategies (i.e. scale from 1–5) among those with knee OA, rather than capturing binary yes/no responses. Although our results support the utility of collecting activity modification data in knee OA research, additional refinement of the appropriate instrument may be needed. Tools that enable the rapid appraisal of disability status among patients are inherently relevant in the clinical practice of Physical Medicine and Rehabilitation. For example, this knowledge may inform the treatment

decision-making process, including timely referrals to physical or occupational therapy. The results of this study provide an initial indication that patient-reported activity modifications may be a promising methodological approach to better accomplish this type of appraisal among patients with knee OA.

Study Limitations

First, due to the relatively small number of participants categorized with modified walking/stair-climbing, some of the non-significant associations could be explained by a lack of power. However, lacking optimal statistical power does not diminish the importance of our significant findings. Namely, that activity modification may indicate early physical declines in knee OA. Second, this was not an epidemiological representative of all persons with knee OA because participants were actively symptomatic and knowingly participated in a clinical study. This may influence the generalizability of our findings. However, the symptomatic and radiographic verification of disease is representative of widely-used inclusion criteria for OA in clinical trials. In addition, these participants had characteristics of patients who are routinely seen in clinical settings. Third, the questions from the Pre-Clinical Disability Questionnaire do not specifically inquire whether modifications are attributable to knee OA. However, we excluded participants with serious medical conditions (e.g. severe neurologic, cardiovascular, gastrointestinal, or hematologic disease, diabetes, etc.) and used screening tools to ensure that enrolled participants were physically able to participate in an exercise treatment program. Therefore, it was reasonable to assume that participant mobility status was meaningfully attributable to the confirmed presence of knee OA. Finally, the cross-sectional design of this analysis inherently precludes any causal inferences. Despite these limitations, the process of disablement in knee OA is poorly understood, and the insights generated from this study provide important evidence on how to advance our scientific understanding of this complex process.

Future studies involving longitudinal designs, larger participant samples, or additional activity types are needed to better understand how modifications influence physical health decline in knee OA. In addition, researchers may consider using performance-based measures of activity modification to complement patient-reported modification data[29]. Importantly, interventional trials may be needed to determine how treatments can modulate mobility status or the progression of functional decline among patients with early signs of disablement. Furthermore, it may be useful to examine whether baseline mobility modifications predict short and long term outcomes.

In conclusion, this study provides initial support that patient-reported activity modifications indicate both patient-reported and performance-based physical health decline among adults with symptomatic knee OA. This knowledge can be used as a preliminary step to enhance symptom evaluation in this patient group. If confirmed, activity modifications may be useful as both an indication of early decline and a mediating risk factor affecting the natural history of disability.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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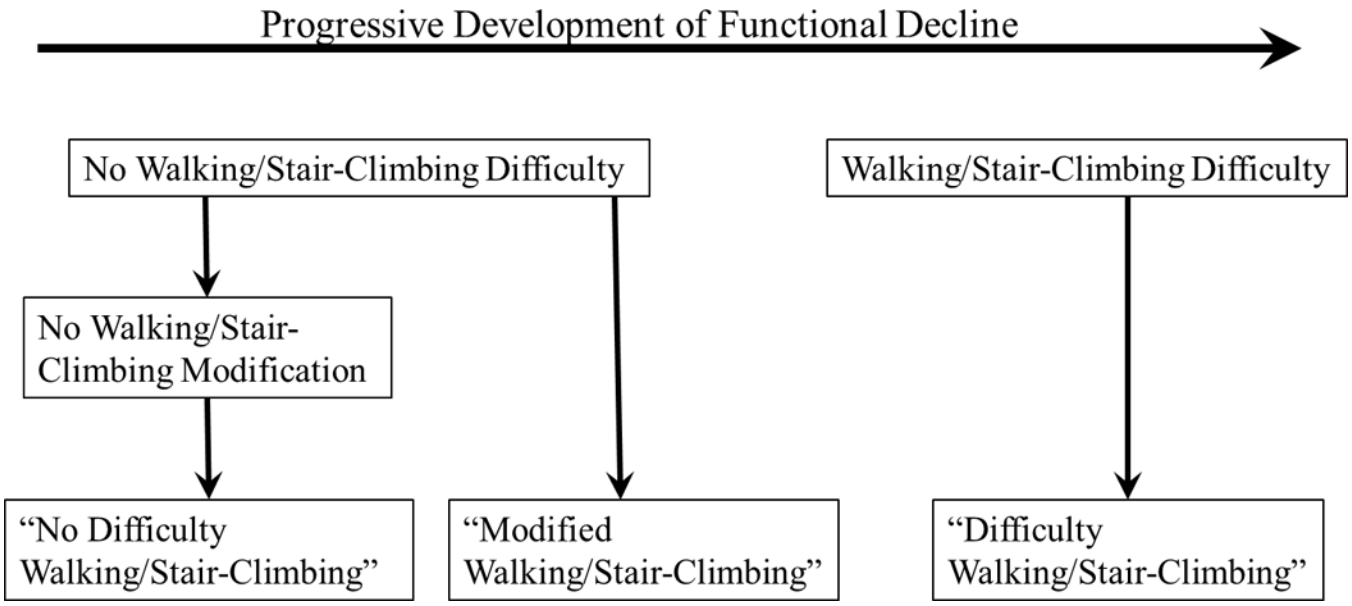

Figure 1. Subgroup Categorization According to Mobility Difficulty and Modification
Figure modified from Manty *et al.* Arch Phys Med Rehabil 2007; 88: 1108-13.

Table 1

Characteristics of All Participants (n = 121)

Variable	Mean ±SD	Median (25th, 75th Percentiles)
Age, years	61.0±9.9	60.0 (53.0, 68.0)
Female Sex, n (%)	88.0 (72.7)	
Race, n (%)		
White	72 (59.5)	
Black	37 (30.6)	
Asian/Other	12 (9.92)	
Duration of knee pain, years	8.5±10.1	5.0(3.0, 10.0)
Kellgren-Lawrence grade, n (%)		
0–1 *	9 (7.6)	
2	47 (39.8)	
3	40 (33.9)	
4	22 (18.6)	
Highest Level of Education, n (%)		
High school Graduate or Less	20 (16.5)	
Some College or more	101 (83.5)	
Body Mass Index, kg/m^2	32.2±7.0	31.4(27.0, 36.5)
WOMAC Pain (Range: 0–500)	123.6±121.2	80.0(30.7, 182.6)
WOMAC Physical Function (Range: 0–1700)	416.2±397.1	268.5(101.0, 674.0)
WOMAC Stiffness (Range: 0–200)	57.4±54.5	38.5(11.5, 100.5)
Patient Global Assessment (Range: 0.0–10.0)	3.5±2.7	3.2(1.3, 5.0)
20-Meter Gait Speed# **, meters/second**	1.22 ± 0.25	1.23(1.06, 1.39)
6-Minute Walk Distance#**, meters**	420.8±89.7	418.7(372.3, 480.0)
10 Repetition Chair Stand Test, seconds	27.8±11.6	26.1(21.6, 31.9)
Berg Balance Score (Range: 0–56#**)**	52.3±3.3	53.0(51.0, 54.0)
1RM Leg Extensor Muscle Strength, newtons#	1058.1±446.1	980.5(748.3, 1270.5)
Muscle Contraction Velocity, meters/second (40% of 1RM)#	0.5±0.1	0.5(0.4, 0.6)
Muscle Contraction Velocity, meters/second (70% of 1RM)#	0.4±0.1	0.4(0.3, 0.4)
Muscle Power watts (40% of 1RM)#	316.6±193.0	276.7(195.7, 374.6)

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Variable	Mean ±SD	Median (25th, 75th Percentiles)
Muscle Power watts (70% of 1RM)#	331.6±165.4	297.7(228.5, 402.9)

1RM= one-repetition maximum; SD= Standard Deviation; WOMAC= Western Ontario and McMasters Osteoarthritis Index. All values are mean ±SD or median (25th, 75th percentiles), unless otherwise specified.

*Osteophyte was confirmed in the patellofemoral joint region for those with Kellgren/Lawrence grade 0 or 1.

#Higher score indicates greater health.

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Table 2

Demographic and Clinical Characteristics of Participants by Walking Activity Function, n=121

Variable		No Difficulty Walking: No difficulty, no modification; n=27	Modified Walking: No difficulty, uses modification; n=9	Difficulty Walking: Activity difficulty; n=85	Global *p*-value	*p*-values from pairwise testing		
						No Difficulty vs. Modified	Difficulty vs. Modified	No Difficulty vs. Difficulty
Age, years		63 (58.0, 73.0)	60 (55.0, 62.0)	59 (52.0, 67.0)	0.31			
Sex, N (%)	**Female**	23(85.2)	8(88.9)	57(67.1)	0.11			
	Male	4(14.8)	1(11.1)	28(32.9)				
Pain duration, years;		5.0 (3.0, 9.5)	10.0 (3.0, 12.0)	5.0 (3.0,10.0)	0.71			
Race, N (%)	**White**	14(51.9)	8(88.9)	50(58.8)	**0.003**	0.11	0.21	**0.0009**
	Black	5(18.5)	1(11.1)	31(36.5)				
	Other	8(29.6)	0(0)	4(4.7)				
Education N (%)	**<=High school**	5(18.5)	1(11.1)	14(16.5)	0.92			
	At least some College	22(81.5)	8(88.9)	71(83.5)				
Kellgren/Lawrence Grade	**0–1** *	4(15.4)	2(22.2)	3(7.6)	**0.02**	1.0	0.07	**0.02**
	2	12(46.1)	4(44.4)	16(39.8)				
	3	9(34.6)	3(33.3)	12(33.9)				
	4	1(3.9)	0(0)	1(18.6)				
Body mass index, kg/m^2		28.9 (25.9, 36.4)	36.1 (30.6, 40.1)	32.0 (27.5, 35.9)	0.12			
WOMAC Pain Score Range, 0–500mm		29.2 (13.0, 75.9)	102.0 (65.0, 183.5)	100.0 (43.9, 194.0)	**0.001**	**0.05**	0.75	**0.0001**
WOMAC Function Score Range, 0–1700mm		80.5 (50.4, 227.0)	263.0 (147.5, 698.4)	329.5 (182.0, 752.5)	**<0.0001**	**0.04**	0.72	**<0.0001**
WOMAC Stiffness Score Range, 0–200mm		8.5 (7.0, 31.5)	77.0 (14.6, 108.0)	42.5 (23.2, 105.0)	**0.0003**	**0.01**	0.48	**0.0001**
Patient Global Assessment Score Range, 0.0–10.0		1.3 (0.5, 2.7)	3.8 (3.2, 5.6)	3.4 (1.6, 5.0)	**0.004**	**0.01**	0.27	**0.003**

Variable	No Difficulty Walking: No difficulty, no modification; n=27	Modified Walking: No difficulty, uses modification; n=9	Difficulty Walking: Activity difficulty; n=85	Global *p*-value	*p*-values from pairwise testing		
					No Difficulty vs. Modified	Difficulty vs. Modified	No Difficulty vs. Difficulty
20 meter gait speed#, m/s	1.32 (1.19, 1.45)	1.27 (1.02, 1.53)	1.18 (1.00, 1.32)	0.07			
6 Minute Walk#, meters	441.1 (405.3, 522.2)	440.7 (351.9, 469.2)	417.5 (364.1, 453.1)	0.11			
10 Repetition Chair Stand Test, seconds	26.1 (19.9, 29.2)	26.2 (22.3, 31.7)	26.2 (21.6, 32.9)	0.74			
Berg Balance Score Range, 0–56#	53.0 (52.0, 54.5)	49.0 (47.0, 53.0)	54.0 (51.0, 54.0)	**0.03**	**0.01**	**0.01**	0.96
1RM Leg Extensor Muscle Strength, newtons#	1045.4 (825.5, 1300.0)	1019.0 (826.7, 1048.6)	948.4 (724.2, 1276.7)	0.65			
Muscle Contraction Velocity, meters/second (40% of 1RM)#	0.4 (0.4, 0.6)	0.5 (0.4, 0.6)	0.5 (0.5, 0.6)	0.47			
Muscle Contraction Velocity, meters/second (70% of 1RM)#	0.3 (0.2, 0.4)	0.4 (0.3, 0.4)	0.4 (0.3, 0.5)	0.13			
Muscle Power watts (40% of 1RM)#	241.7 (189.7, 408.9)	245.5 (178.8, 342.0)	282.7 (207.5, 362.6)	0.72			
Muscle Power watts (70% of 1RM)#	265.7 (223.8, 367.9)	319.3 (248.2, 375.9)	309.2 (236.2, 415.7)	0.74			

1RM= one-repetition maximum; WOMAC= Western Ontario and McMasters Osteoarthritis Index. Values are median (25^{th}, 75^{th} percentiles) unless stated otherwise.

*Osteophyte was confirmed in the patellofemoral joint region for those with Kellgren/Lawrence grade 0 or 1.

#Higher score indicates greater health.

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Table 3

Demographic and Clinical Characteristics of Participants by Stair Climbing Activity Function, n= 106

Variable		No difficulty Stair-Climbing: No difficulty, no modification; n=28	Modified Stair-Climbing: No difficulty, uses modification; n=9	Difficulty Stair-Climbing: Activity Difficulty; n=69	Global *p*-value	*p*-values from pairwise testing		
						No Difficulty vs. Modified	Difficulty vs. Modified	No Difficulty vs. Difficulty
Age, years		63 (58.0, 73.5)	58.0 (55.0, 61.0)	59.0 (52.0, 66.0)	0.08			
Sex, N (%)	**Female**	23(82.14)	9(100)	46(66.7)	**0.04**	0.31	**0.05**	0.15
	Male	5(17.86)	0(0)	23(33.3)				
Pain duration, years;		6.0 (3.0, 10.0)	10.0 (5.0, 12.0)	5.0 (3.0, 10.0)	0.11			
Race, N (%)	**White**	20(71.4)	7(77.8)	37(53.6)	0.16			
	Black	4(14.3)	1(11.1)	25(36.2)				
	Other	4(14.3)	1(11.1)	7(10.1)				
Education, N (%)	**≤High school**	5(17.9)	1(11.1)	12(17.4)	1.00			
	At least some College	23(82.1)	8(88.9)	57(82.6)				
Kellgren/Lawrence Grade	**0–1** *	2(7.4)	1(11.1)	6(9.0)	0.79			
	2	13(48.1)	4(44.4)	26(38.8)				
	3	10(37.0)	3(33.3)	21(31.3)				
	4	2(7.4)	1(11.1)	14(20.9)				
Body Mass Index, kg/m^2		29.3 (25.2, 36.3)	39.5 (27.1, 41.1)	32.0 (28.3, 35.9)	*0.14*			
WOMAC Pain * **Score Range, 0–500mm**		31.3 (14.5, 81.0)	52.0 (14.5, 117.0)	136.0 (53.7, 235.6)	**0.0002**	0.43	0.08	**<0.0001**
WOMAC Function * **Score Range, 0–1700mm**		106.3 (50.2, 235.6)	227.0 (62.0, 316.5)	488.5 (224.0, 864.5)	**<0.0001**	0.12	0.09	**<0.0001**
WOMAC Stiffness Score Range, 0–200mm		13.0 (7.5, 37.0)	14.5 (11.5, 51.0)	56.0 (24.0, 111.5)	**0.002**	0.27	0.19	**0.001**
Patient Global Assessment		1.4 (0.7, 3.5)	2.4 (1.6, 8.6)	4.5 (1.9, 5.6)	**0.007**	0.08	0.92	**0.002**

Variable	No difficulty Stair-Climbing: No difficulty, no modification; n=28	Modified Stair-Climbing: No difficulty, uses modification; n=9	Difficulty Stair-Climbing: Activity Difficulty; n=69	Global *p*-value	*p*-values from pairwise testing		
					No Difficulty vs. Modified	Difficulty vs. Modified	No Difficulty vs. Difficulty
Score Range, 0.0–10.0							
20 meter Gait Speed#, m/s	1.293 (1.23, 1.465)	1.18 (1.00, 1.31)	1.16 (0.98, 1.34)	**0.007**	0.08	0.90	**0.002**
6 Minute Walk#, meters	492.3 (417.3, 527.8)	406.9 (361.0, 436.2)	401.9 (366.7, 443.4)	**0.001**	**0.03**	0.82	**0.0003**
10 Repetition Chair Stand Test, seconds	23.9 (19.5, 27.8)	31.4 (23.5, 34.8)	26.1 (21.8, 33.2)	0.13			
Berg Balance Score Range, 0–56#	53.0 (52.0, 54.0)	52.0 (50.0, 54.0)	53.0 (51.0, 54.0)	0.38			
1RM Leg Extensor Muscle Strength, newtons#	1070.6 (825.5, 1300.0)	1235.8 (857.9, 1295.9)	849.5 (695.5, 1121.5)	0.30			
Muscle Contraction Velocity, meters/second (40% of 1RM)#	0.5 (0.4, 0.6)	0.4 (0.4, 0.5)	0.5 (0.5, 0.6)	0.26			
Muscle Contraction Velocity, meters/second (70% of 1RM)#	0.3 (0.3, 0.4)	0.3 (0.3, 0.4)	0.4 (0.3, 0.4)	0.42			
Muscle Power watts (40% of 1RM)#	294.8 (196.3, 386.5)	269.7 (233.8, 274.7)	265.8 (202.0, 314.9)	0.76			
Muscle Power watts (70% of 1RM)#	271.0 (223.8, 369.2)	302.1 (265.5, 359.6)	269.5 (236.2, 382.1)	0.99			

1RM= one-repetition maximum; WOMAC= Western Ontario and McMasters Osteoarthritis Index. Values are median (25^{th}, 75^{th} percentiles) unless stated otherwise.

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