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The influence of knee pain location on symptoms, functional status and knee-related quality of life in older adults with chronic knee pain: data from the Osteoarthritis Initiative

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Abstract

Objective—To evaluate whether knee pain location can influence symptoms, functional status and knee-related quality of life in older adults with chronic knee pain.

Methods—A total of 2959 painful knees from the Osteoarthritis Initiative database were analyzed. Trained interviewers recorded patient-reported location of knee pain. Painful knees were divided into three groups of patellofemoral only pain, tibiofemoral only pain, and combined pain. Self-reported knee-specific symptoms, functional status and knee-related quality of life were assessed using the Knee Injury and Osteoarthritis Outcome Score (KOOS).

Results—The most common knee pain pattern was tibiofemoral only pain (62%), followed by patellofemoral only pain (23%) and combined pain (15%). The combined pain pattern was associated with greater odds of reporting pain, symptoms, sports or recreational activity limitations and lower knee-related quality of life compared to either isolated knee pain patterns, after adjusting for demographics and radiographic disease severity. Individual item analysis further revealed that patients with combined pain had greater odds of reporting difficulty with daily weightbearing activities that required knee bending compared to tibiofemoral or patellofemoral

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CONFLICTS OF INTEREST

The authors declare no potential conflict of interest.

only pain patterns. Furthermore, symptoms, functional status, and knee-related quality of life were comparable between patients with patellofemoral and tibiofemoral only pain patterns, after adjusting for demographics and radiographic disease severity.

Discussion—Combined patellofemoral and tibiofemoral pain is associated with poorer clinical presentation compared to isolated knee pain from either location. Additionally, patellofemoral pain in isolation may be as important as tibiofemoral pain in causing symptoms and functional limitation in older adults with chronic knee pain.

Keywords

Knee pain; Patellofemoral joint; Tibiofemoral Joint

INTRODUCTION

Chronic knee pain is a major cause of functional limitations and disability in older adults and accounts for a significant number of visits to health care providers.[1-4] Although chronic knee pain in older adults is usually attributed to progressive and degenerative joint changes associated with knee osteoarthritis (OA), functional impairments in this patient population do not appear to be an inevitable consequence of increased structural damage and disease severity.[5-8] To this end, presence of knee pain has been suggested to be a better predictor of functional status in patients with knee OA than radiographic disease severity.[9-11] Additionally, the association between radiographic disease severity and functional impairments often disappears after adjusting for knee pain, further highlighting the influence of pain on function in older adults with knee OA.[10,12-14]

It has been reported that nearly half of adults over the age of 50 report knee pain in a one year period.[15] Furthermore, the onset of new knee pain has been associated with a substantial and persistent reduction of physical function in older adults living in the community.[2] Since knee pain is common and the associated reduction in physical function is a strong predictor of future disability and dependency, early treatment of pain-related functional limitations is likely to have a major influence on healthy ageing for older adults with chronic knee pain. However, little is currently known about the impact of knee pain location on presence of specific functional difficulties that could lead to chronic disability and decline in quality of life in older adults with knee pain.

Although many previous investigations have highlighted increased functional impairments and mobility disability in older adults with chronic knee pain,[1,2,16,17] only a few studies have evaluated the influence of pain location or knee pain patterns on clinical presentation of this patient population. Several cross-sectional studies have reported that isolated medial knee joint pain and generalized (i.e. combined medial, lateral, and patellofemoral) knee pain are the two most commonly observed pain patterns in older adults.[18-20] Patients with generalized knee pain often have more severe and persistent pain, greater worsening of pain at night, higher levels of morning knee joint stiffness, and greater difficulty with weightbearing activities that involve knee bending compared to patients with other knee pain patterns.[18,20] In comparison, patients with isolated medial knee joint pain generally have better functional scores compared to those with generalized knee pain but have greater pain

during standing.[18] Despite important differences in symptoms and functional ability, patients with generalized and isolated medial knee joint pain appear to have similar demographic, radiographic disease severity and psychosocial characteristics, suggesting that the location of pain may be a distinct determinant of clinical presentation in this patient population.[18]

One potential reason for more severe symptoms and greater functional limitations in patients with generalized knee pain may be the presence of coexisting patellofemoral pain. As the majority of scientific literature regarding chronic knee pain in older adults has focused on the involvement of the tibiofemoral joint, symptoms and function limitations caused by patellofemoral joint dysfunction has gone largely unexamined.[21,22] Patellofemoral pain is a common musculoskeletal condition that has a tendency to become chronic and lead to significant functional limitations in young and middle-age patients.[23-25] Despite the misconception that patellofemoral pain is a benign and self-limiting disorder, evidence suggest that chronic patellofemoral pain increases the risk of structural disease development and continued symptoms later in life.[26,27] Although presence of patellofemoral pain is a common finding in older adults with chronic knee pain,[19,28] the clinical impact of patellofemoral pain has not been fully elucidated and there is very little known about how to effectively manage it.[21,22]

The aim of this study was to evaluate whether the location and pattern of pain in older adults with chronic knee pain is associated with increased symptoms, difficulty with daily living, sports or recreation activities, and lower knee-related quality of life based on the summary scores of a knee-specific, patient-reported outcome measure. An additional and exploratory aim of this study was to determine whether the location of pain in older adults with chronic knee pain is associated with specific patterns of difficulty with particular daily living activities on the individual items of a patient-reported outcome measure.

MATERIALS AND METHODS

Study Population

Data used in the preparation of this article were obtained from the Osteoarthritis Initiative (OAI) database, which is available for public access at http://www.oai.ucsf.edu/. The OAI is a National Institutes of Health (NIH) sponsored multi-center, longitudinal, prospective observational study of 4,796 men and women between 45-79 years of age. At baseline the cohort was divided into a progression cohort of 1390 participants with symptomatic knee OA (defined as frequent knee symptoms and radiographic tibiofemoral knee OA in at least one knee) and an incidence cohort of 3285 participants without symptomatic knee OA (defined as having specific characteristics that give them an increased risk of developing symptomatic knee OA). OAI participants were enrolled through community-based recruitment at 5 clinical centers including the University of Pittsburgh, Pittsburgh, Pennsylvania; Ohio State University, Columbus, Ohio; Memorial Hospital, Pawtucket, Rhode Island; the University of Maryland and Johns Hopkins Bayview Medical Center, Baltimore, Maryland. All participants provided written informed consent using forms approved by the participating institutions' review boards.

Assessment of Knee Pain Location

Pain location in participants with pain in at least 1 knee over the previous 30 days was assessed using the Knee Pain Map, which is an interviewer-administered assessment tool that identifies area(s) of the knee that are perceived by the patient to be painful.[19] The Knee Pain Map consists of an artist's drawing of the patient's knee from the point of view of the examiner while the patient is sitting on the edge of an examination table with knees flexed to 90 degrees. The patient is instructed to use the tip of their finger to point to the area or areas on their own knee where they have pain or have had pain over the past 30 days. If they cannot use a finger to pinpoint the area(s) of pain, they are then asked to use their hand to cover the region of their knee that is deemed painful. The interviewer uses the knee pain map to record the knee pain location(s) pointed to by the patient. Excellent inter-rater and intra-rate reliability (kappa coefficients 0.7-1.0) for identification of knee pain location in patients with chronic pain has been reported for the Knee Pain Map.[19]

Location of knee pain for each participant is then classified as one of three categories of localized, regional, or diffuse. Localized knee pain was classified as patients pointing with one finger to one of seven localized area(s) with pain (superior medial, medial knee joint line, inferior medial, patella, superior lateral, lateral knee joint line, or inferior lateral). Regional knee pain is defined as participants indicating the location of their pain by putting their entire hand over one of four regional areas of pain (medial, patella, lateral, or back of the knee). To simplify the process of pattern analysis, we combined the localized and regional knee pain over the patella as patellofemoral pain, localized and regional knee pain elsewhere as tibiofemoral pain, and pain over both the patella and at least one other location as combined pain. If participants reported more than four local areas of pain or more than two regions of pain in a knee, or said that they hurt everywhere, their pain was classified as diffuse pain that cannot be localized or generalized and were subsequently excluded from this study. The Knee Pain Map was administered at the 24-month OAI visit.

Symptoms, Function and Knee-Related Quality of Life

The Knee Injury and Osteoarthritis Outcome Score (KOOS) questionnaire administered at the 24-month OAI visit was used to assess the level of pain, symptoms, limitations with activities of daily living (ADL), function in sport and recreation (sport/recreation), and knee-related quality of life (QOL).[29] The KOOS is an extension of the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) which is the most commonly used, valid and reliable disease-specific measure of pain, stiffness and physical function for individuals with knee OA.[30-33] The KOOS evaluates both short-term and long-term consequences of knee injury and has been validated for use in patients with post-traumatic[29] or different stages of knee OA.[34] To calculate a summary score for each KOOS subscale, standardized answer options are given (5 Likert boxes) and each question is assigned a score from 0 to 4. A normalized score (100 indicating no symptoms and 0 indicating extreme symptoms) is then calculated for each subscale.

Statistical Analysis

The data were summarized using frequencies and percentages for categorical variables and medians and interquartile range (IQR) for continuous variables. To compare differences

across pain groups, the chi-squared test was used for categorical variables whereas the Kruskal-Wallis test was used for continuous variables due to skewness of the distributions. Separate generalized *mixed* linear models were created to estimate main effects between groups for limb-specific KOOS subscales (i.e. pain, other symptoms, and ADL). The pain location and limb-specific KOOS subscale scores were matched for the right and the left knees and were used as separate units in each model given that Knee Pain Map and the KOOS questionnaire data were collected separately for each knee. Since subjects could contribute twice when both limbs were painful, the generalized *mixed* linear models included one random intercept at the subject-level to account for the clustering of knees within an individual. Additionally, generalized linear models were used for the KOOS subscale data that were not limb-specific (sport/recreation and QOL) and the pain category for analysis was chosen as the painful knee if reporting unilateral pain or the most painful knee if reporting bilateral pain. Given that normality assumptions were not met and log transformation did not improve the normality of the continuous KOOS subscale scores, previously defined cut points were used to dichotomize the outcome scores into symptomatic versus non-symptomatic knees.[35] After conversion to a 0 to 100 scale, the cutoffs for having a symptomatic knee on each subscale were defined as follows: pain ≤ 86.1, symptoms ≤ 85.7, ADL ≤ 86.8, sport/recreation ≤ 85.0, and QOL ≤ 87.5. These cut-off ranges have been previously used to identify individuals symptomatic enough to possibly seek medical care.[35-37]

For specific-item analyses of the questions contained within the ADL subscales of KOOS, Likert scale responses to each question were dichotomized as “none, mild” versus “moderate, severe, extreme” in order to identify individuals symptomatic enough to possibly seek medical care as most patients seek treatment after they have developed at least moderate level of difficulty with a task. Due to the exploratory and hypothesis-generating nature of this analysis, multiplicity adjustments were not performed. All models in the study were adjusted for age, gender, race, body mass index (BMI), tibiofemoral joint radiographic disease severity and the clinical center where the data was collected (Table 1). When missing data occurred, the missing completely at random (MCAR) assumption in the generalized linear models and the missing at random (MAR) assumption in the generalized linear *mixed* models were applied directly. Statistical analyses were performed using SAS (version 9.2; SAS Institute, Cary, NC). Two sided p-values of less than 0.05 were considered as statistically significant.

RESULTS

Knee pain map data for 7,446 knees were available for analysis. A total of 2,941 knees from participants who at the time of evaluation reported no current or past knee pain were omitted from this study. An additional 1,546 knees were excluded from analysis due to having diffuse pain, patient's inability to localize or remember the location of pain, or missing data. Therefore, the final analysis included a total of 2,959 painful knees from 1,952 participants. The most common pain pattern reported by the cohort was tibiofemoral only pain (n = 1831; 62%), followed by patellofemoral only pain (n= 673; 23%) and combined pain (n = 455; 15%).

Table 1 outlines the patient-level characteristics and knee pain risk factors for the patients according to the pain pattern category of their painful knee (if reporting unilateral pain) or the most painful knee (if reporting bilateral pain). No statistically significant differences between the three pain groups were evident in terms of gender, age, or BMI. Nearly half of the participants in each pain category did not meet the radiographic disease severity criteria for tibiofemoral OA of grade 2 or higher. Furthermore, the distribution of radiographic disease severity was not different between the tibiofemoral only and the combined knee pain groups. However, the patellofemoral only pain group demonstrated a greater percentage of knees with low disease severity scores of 0-2 and lower percentage of knees with high disease severity scores of 3-4 compared to the tibiofemoral only and the combined knee pain groups. Significant race and recruitment center effects were also observed between the three pain groups which were subsequently adjusted for in all statistical analyses.

KOOS Summary Subscale Scores

Overall, a large percentage of knees in each knee pain subset met the criteria for greater self-reported pain, symptoms, sports/recreational activity limitations and lower knee-related quality of life (Table 2). The combined pain group had the highest proportion of knees with greater levels of pain, other symptoms, sports/recreational activity limitations, and lower knee-related QOL compared to the tibiofemoral and patellofemoral only pain groups, after adjusting for demographics and radiographic disease severity (Table 2). Conversely, only a very small proportion of knees met the criterion for having symptomatic knees on the ADL subscale across the 3 knee pain subsets, with no differences detected between groups. Additionally, no differences were observed in any of the KOOS subscale scores between the patellofemoral and tibiofemoral only pain groups (Table 2).

Activities of Daily Living Limitations

When compared to both isolated pain groups, the combined pain group reported greater difficulty with going up or down stairs, getting up from a sitting position, bending to the floor, going shopping, and performing heavy and light household chores on the specific items included on the ADL subscale of the KOOS (Table 3). The combined pain group also reported more difficulty with standing, lying or getting out of bed compared to the patellofemoral only pain group and greater difficulty with getting in or out the car and getting off the toilet compared to the tibiofemoral only pain group. Additionally, patients with tibiofemoral only pain had more difficulty while standing compared to those with patellofemoral only pain.

DISCUSSION

As expected and consistent with previous reports,[18,20] presence of combined tibiofemoral and patellofemoral pain was associated with greater self-reported pain, symptoms, activity limitations, and lower knee-related QOL compared to pain in either knee region in isolation. It is important to note that these differences persisted after controlling for important pain-related risk factors such as age, gender, BMI and tibiofemoral joint radiographic disease severity. Given that the combined pain group was worse off when compared separately to each isolated knee pain group suggests that pain from both knee regions likely contributed to

the poorer clinical presentation of this patient population. However, determining which region is driving the greater reports of symptoms, more activity limitations, and worst knee-related QOL in patients with combined knee pain was not possible as having pain in both knee regions most likely interact to produce an additive effect. Given the distinct differences in structure and function of the tibiofemoral and patellofemoral regions, our findings suggest that a comprehensive intervention strategy for management of patients with combined knee pain pattern should include components to specifically and separately address pain arising from each knee region. This assertion supports the recommendations by most clinical guidelines for tailoring management strategies for patients with chronic knee pain due to OA to match their clinical presentation for attaining optimal clinical outcomes.[38,39]

Our results also indicate that a high percentage of patients with patellofemoral only pain had significant levels of self-reported knee pain (57.5%), other symptoms (49.3%), limitations with sports/recreational activities (74.3%) and diminished knee-related QOL (91.6%; Table 2). Interestingly, these percentages were comparable to those reported by patients with tibiofemoral only pain. This finding suggests that pain arising from the patellofemoral region may be as important as tibiofemoral pain in influencing a patient with chronic knee pain to seek medical care. Yet, studies to better understand and more effectively manage patellofemoral joint symptoms and the related functional limitations in older adults with chronic knee pain continue to receive little attention in the literature.[21,22] Thus, further efforts to develop and validate effective approaches that specifically address patellofemoral pain in older adults with chronic knee pain, such as those successfully used in management of patellofemoral pain in younger patients[40-42] may be worthy of continued research.

The finding that only a small percentage (< 2%) of patients across the three pain groups met the previously established criteria for having significant activity limitations on the ADL subscale of the KOOS was surprising. One explanation for the lack of self-reported activity limitations for patients in our study could be that more than half of the participants did not meet the criteria for radiographic tibiofemoral OA, which is consistent with previous reports in the OAI cohort.[43] It is possible that chronic knee pain in this population is a sign of early or subclinical disease, which places them at increased risk of future functional deficit.[44,45] Yet, it cannot be assumed that this cohort of patients with chronic knee pain were completely free of functional deficits based solely on their summary KOOS ADL subscale scores. It could be argued that the apparent lack of functional limitations on the summary ADL subscale score could be the result of averaging a few high demanding and problematic activities such as stairs climbing and standing up from a sitting position with a greater number of lower demanding and non-problematic tasks such as lying in bed or taking one's socks off to calculate a summary subscale score. To this end, discordance between the KOOS ADL subscale score and performance-based measures of important daily activities such as gait and stairs climbing has been previously reported.[46-48] Therefore, determining which particular activities of daily living are deemed problematic by patients with different pain patterns would be a valuable indicator of current and future functional status in this patient population.

To investigate which particular activities were deemed problematic by patients within each pain subset, our exploratory individual item analyses revealed that combined pain was

associated with greater difficulty with most weightbearing activities of daily living that required knee bending. This is an important finding as sharp declines in weightbearing activities that required knee bending, such as stair climbing and a simulated car task performance, have been previously reported in older adults with chronic knee pain over a 30-month timespan.[14] Given the high demands placed on the knee extensors during weightbearing tasks that require knee bending, the greater reports of difficulty with such activities in patients with combined knee pain pattern may be related to diminished quadriceps strength which is known to be an important determinant of functional loss in patients with knee pain.[18,49] It is also plausible that increased knee range of motion requirements during weightbearing activities such as going up and down stairs or standing up from a chair can significantly elevate tibiofemoral and patellofemoral joint compression forces, leading to greater pain in both knee regions and thus rendering task performance difficult. In support of this notion, peak tibiofemoral joint compression force has been reported to be 80% higher at 90 degrees of knee flexion compared to much lower knee angles of 15-20 degrees commonly utilized during the stance phase of gait.[50] The magnitude of the patellofemoral joint compression force during common weightbearing activities has also been reported to increase by 3-7 times body weight at higher knee flexion angles of up to 90 degrees.[51,52]

Patients with combined pain also reported greater difficulty with going shopping and performing heavy and light household chores compared to either isolated knee pain groups. Given the high inter-individual variability in how these tasks are performed, it is difficult to determine the exact cause of greater difficulty reported by patients with combined pain in our study. However, given that limitations with these important daily activities may require undesired lifestyle modifications that could lead to diminished quality of life, further investigation of the underlying reasons for the reported difficulties with such tasks is warranted. Additionally, the combined pain group also reported more difficulty with standing and lying or getting out of bed compared to the patellofemoral only pain group. Because both groups had patellofemoral pain in common within the context of this comparison, the greater report of difficulty by the combined pain group could be more specifically attributed to the addition of pain arising from the tibiofemoral region. Patients with combined pain also reported greater difficulty with getting in or out the car and getting off the toilet compared to the tibiofemoral only pain group. As both groups had tibiofemoral pain in common, the greater difficulty reported by the combined pain group could be attributed to their patellofemoral pain symptoms.

This study has several limitations which need to be addressed. First, our cross-sectional design precludes inferences on causal relationships between patterns of pain and limitations with specific activities of daily living. Future studies should investigate if location of pain predicts functional decline and disability in older adults with knee pain. Second, other factors such as medication use, pain-related activity avoidance, and depression symptoms may have influenced the self-reported limitations of the participants, but it was beyond the scope of this study to examine the many possible contributors of the pain-function relationship. The lack of radiographic assessment of the patellofemoral joint is another limitation of this study. In an investigation of community-dwelling individuals over the age 55, more than half of whom reported knee pain, isolated symptomatic patellofemoral joint

OA was noted in only 8% of the women and 2% of the men.[53] Therefore, lack of assessment of the patellofemoral joint in the present study may have resulted in a slight underestimation of radiographic knee OA. However, given the stronger predictive value of pain over radiographic disease severity, the absence of radiographic patellofemoral disease severity does not alter the clinical implications of our findings as treatment decisions are often made based on pain presentation and not radiographic disease severity. Finally, although the KOOS has shown to be a valid, reliable, and responsive outcome measure,[54,55] the single-item assessment of the questions contained within its ADL subscale has not been adequately tested and should be further researched. However, single items are the essence of any multiple-item questionnaire and in the case of the KOOS, the face and content validity of each item is supported by the fact that they were selected with extensive input from patients with knee OA as well as clinicians who are in charge of their care.[55]

CONCLUSIONS

Pain and functional disability are the principle reasons why patients with chronic knee pain seek medical treatment. The findings of the current study suggest that presence of combined tibiofemoral and patellofemoral pain may have an additive effect, leading to greater pain, symptoms and worse knee-related QOL. Therefore, consideration should be given to examining and tailoring treatments to both knee regions in patients with combined knee pain pattern. Additionally, given that patients' perception of their functional limitations may have important impact on diagnosis-seeking and treatment decision-making behaviors, targeted treatment of limitations with weightbearing functional task that require knee bending could be an effective strategy in addressing the potential declines in quality of life and disability in older adults with combined knee pain. Additionally, patellofemoral pain may be as likely a cause of symptoms and functional limitation as tibiofemoral pain in older adults with chronic knee pain. Further research to develop and validate effective approaches that specifically address patellofemoral pain in older adults with chronic knee pain may be warranted.

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Table 1

Subject level characteristics stratified by the more painful limb.

	Patellofemoral Pain (n = 404)	Tibiofemoral Pain (n =1248)	Combined Pain (n = 300)	p-value[a]
Age, median, IQR	61.5 (55.0, 69.0)	62.00 (55.0, 70.0)	61.00 (55.0, 69.0)	0.87
Female, n (%)	231 (57.2)	685 (54.9)	186 (62.0)	0.08
Race, n (%)				<0.001
White or Caucasian	319 (79.0)	1052 (84.3)	229 (76.3)	
African American	70 (17.3)	175 (14.0)	66 (22.0)	
Others	15 (3.7)	21 (1.7)	5 (1.7)	
BMI, n (%)				0.14
BMI < 25	101 (25.0)	279 (22.3)	61 (20.3)	
25 ≤ BMI < 30	139 (34.4)	499 (40.0)	109 (36.3)	
30 ≤ BMI	164 (40.6)	470 (37.7)	130 (43.3)	
Radiographic Tibiofemoral Joint Disease severity, n (%)				
Grade 0	68 (16.8)	179 (14.3)	43 (14.3)	0.003
Grade 1	155 (38.4)	418 (33.5)	101 (33.7)	
Grade 2	79 (19.6)	194 (15.5)	47 (15.7)	
Grade 3	78 (19.3)	299 (24.0)	78 (26.0)	
Grade 4	24 (5.9)	158 (12.7)	31 (10.3)	
Clinical Center, n (%)[b]				<0.0001
A	60 (14.9)	159 (12.7)	61 (20.3)	
B	42 (10.4)	259 (20.8)	30 (10.0)	
C	163 (40.3)	371 (29.7)	129 (43.0)	
D	92 (22.8)	390 (31.3)	66 (22.0)	
E	47 (11.6)	69 (5.5)	14 (4.7)	

BMI = body mass index; IQR = interquartile range

[a] For continuous variables, Kruskal-Wallis test is used. For categorical variable, Chi-squared test is used.

[b] Blinded clinical site indicators as they appear in the publically available Osteoarthritis Initiative (OAI) database.

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Table 2

The association between patterns of knee pain and self-reported symptomatic knee osteoarthritis on the Knee injury and Osteoarthritis Outcome Score (KOOS) subscale summary scores.

KOOS Subscales	Patellofemoral Pain vs. Tibiofemoral Pain†	Combined Pain vs. Tibiofemoral Pain†	Combined Pain vs. Patellofemoral Pain†
Pain			
Odds Ratio (95% CI)[a]	0.89 (0.72, 1.11)	1.64 (1.25, 2.13)*	1.82 (1.35, 2.44)*
Group Percentages	57.5% vs. 61.0%	73.4% vs. 61.0%	73.4% vs.58.0%
Symptoms			
Odds Ratio (95% CI)[a]	0.89 (0.71, 1.11)	1.54 (1.19, 2.00)*	1.72 (1.28, 2.38)*
Group Percentages	49.3% vs. 52.3%	64.4% vs. 52.3%	64.4% vs. 49.3%
Activities of Daily Living			
Odds Ratio (95% CI)[a]	0.85 (0.22, 3.23)	2.56 (0.81, 8.33)	3.03 (0.72, 12.50)
Group Percentages	0.6% vs. 0.5%	1.8% vs. 0.5%	1.8% vs. 0.6%
Function, Sports, and Recreational Activities			
Odds Ratio (95% CI)[b]	0.81 (0.61, 1.08)	1.56 (1.08, 2.22)*	1.92 (1.27, 2.86)*
Group Percentages	74.3% vs. 78.5%	86% vs. 78.5%	86.0% vs. 74.3%
Quality of Life			
Odds Ratio (95% CI)[b]	1.15 (0.76, 1.75)	2.38 (1.28, 4.35)*	2.08 (1.04, 4.17)*
Group Percentages	91.6% vs. 91.0%	96% vs. 91.0%	96.0% vs. 91.6%

[a]Generalized linear mixed models, adjusted for age, gender, race, body mass index, clinical center, and radiographic disease severity.

[b]Generalized linear models, adjusted for age, gender, race, body mass index, clinical center, and radiographic disease severity.

†Reference group for comparisons

*Significantly different than the reference group ($P < 0.05$)

Table 3

The associations between patterns of knee pain and self-report of difficulty performing activities of daily living on the individual items of the Knee Injury and Osteoarthritis Outcome Score (KOOS) Activities of Daily Living subscale.[ab]

Function in Daily Living Subscale	Patellofemoral Pain vs. Tibiofemoral Pain[†]	Combined Pain vs. Tibiofemoral Pain[†]	Combined Pain vs. Patellofemoral Pain[†]
Difficulty when going down stairs			
Odds Ratio (95% CI)	0.89 (0.67, 1.18)	1.48 (1.10, 1.99)*	1.67 (1.17, 2.37)*
Group Percentages	18.3% vs. 20.5%	28.4% vs. 20.5%	28.4% vs. 18.3%
Difficulty when going up stairs			
Odds Ratio (95% CI)	1.12 (0.86, 1.45)	1.92 (1.45, 2.54)*	1.71 (1.24, 2.38)*
Group Percentages	25.1% vs. 22.5%	37.1% vs. 22.5%	37.1% vs. 25.1%
Difficulty when getting up from a sitting position			
Odds Ratio (95% CI)	1.04 (0.79, 1.37)	1.66 (1.23, 2.23)*	1.60 (1.13, 2.26)*
Group Percentages	20.7% vs. 19.5%	30.1% vs. 19.5%	30.1% vs. 20.7%
Difficulty when standing			
Odds Ratio (95% CI)	0.62 (0.42, 0.92)*	1.34 (0.93, 1.93)	2.14 (1.35, 3.41)*
Group Percentages	7.4% vs. 10.2%	14.8% vs. 10.2%	14.8% vs. 7.4%
Difficulty when bending to the floor			
Odds Ratio (95% CI)	0.98 (0.75, 1.28)	1.48 (1.11, 1.99)*	1.51 (1.07, 2.13)*
Group Percentages	25.4% vs. 25.7%	35.5% vs. 25.7%	35.5% vs. 25.4%
Difficulty when walking on a flat surface			
Odds Ratio (95% CI)	0.78 (0.53, 1.17)	1.20 (0.81, 1.78)	1.54 (0.95, 2.49)
Group Percentages	7.1% vs. 8.8%	11.9% vs. 8.8%	11.9% vs. 7.1%
Difficulty when getting in or out of the car			
Odds Ratio (95% CI)	1.13 (0.85, 1.49)	1.57 (1.16, 2.12)*	1.39 (0.98, 1.98)
Group Percentages	20.8% vs. 18.5%	28.4% vs. 18.5%	28.4% vs. 20.8%

Function in Daily Living Subscale	Patellofemoral Pain vs. Tibiofemoral Pain†	Combined Pain vs. Tibiofemoral Pain†	Combined Pain vs. Patellofemoral Pain†
Difficulty when going shopping			
Odds Ratio (95% CI)	0.80 (0.55, 1.15)	1.52 (1.06, 2.18)*	1.90 (1.22, 2.96)*
Group Percentages	10.2% vs. 11.3%	18.6% vs. 11.3%	18.6% vs. 10.2%
Difficulty when putting on socks or stockings			
Odds Ratio (95% CI)	0.83 (0.57, 1.21)	1.19 (0.81, 1.74)	1.43 (0.90, 2.27)
Group Percentages	9.2% vs. 10.4%	13.6% vs. 10.4%	13.6% vs. 9.2%
Difficulty when getting out of bed			
Odds Ratio (95% CI)	0.63 (0.20, 1.97)	2.45 (0.95, 6.33)	3.90 (1.11, 13.72)*
Group Percentages	12.9% vs. 11.8%	18.9% vs. 11.8%	18.9% vs. 12.9%
Difficulty when taking off your socks or stockings			
Odds Ratio (95% CI)	0.93 (0.63, 1.38)	1.30 (0.87, 1.94)	1.39 (0.86, 2.25)
Group Percentages	8.5% vs. 8.6%	12.5% vs. 8.6%	12.5% vs. 8.5%
Difficulty when lying in bed			
Odds Ratio (95% CI)	0.65 (0.42, 1.00)	1.24 (0.82, 1.87)	1.91 (1.13, 3.21)*
Group Percentages	5.5% vs. 7.8%	10.6% vs. 7.8%	10.6% vs. 5.5%
Difficulty when getting in or out of the bathtub			
Odds Ratio (95% CI)	1.03 (0.68, 1.56)	1.43 (0.92, 2.22)	1.39 (0.83, 2.34)
Group Percentages	13.2% vs. 11.6%	18.9% vs. 11.6%	18.9% vs. 13.2%
Difficulty when sitting			
Odds Ratio (95% CI)	0.90 (0.58, 1.38)	1.10 (0.70, 1.71)	1.22 (0.72, 2.09)
Group Percentages	6.2% vs. 6.9%	8.8% vs. 6.9%	8.8% vs. 6.2%
Difficulty when getting on or off the toilet			
Odds Ratio (95% CI)	1.38 (0.97, 1.97)	1.82 (1.26, 2.63)*	1.32 (0.86, 2.02)
Group Percentages	13.2% vs. 9.8%	18.9% vs. 9.8%	18.9% vs. 13.2%
Difficulty with heavy household chores			

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Function in Daily Living Subscale	Patellofemoral Pain vs. Tibiofemoral Pain[†]	Combined Pain vs. Tibiofemoral Pain[†]	Combined Pain vs. Patellofemoral Pain[†]
Odds Ratio (95% CI)	1.04 (0.78, 1.39)	1.61 (1.18, 2.21)[*]	1.55 (1.08, 2.24)[*]
Group Percentages	20.9% vs. 19.3%	29.4% vs. 19.3%	29.4% vs. 20.9%
Difficulty with light household chores			
Odds Ratio (95% CI)	0.95 (0.63, 1.43)	1.69 (1.13, 2.52)[*]	1.78 (1.10, 2.88)[*]
Group Percentages	8.4% vs. 7.6%	13.9% vs. 7.6%	13.9% vs. 8.4%

CI = confidence interval

[a] Generalized linear mixed models adjusted for age, gender, race, body mass index, clinical center, and radiographic disease severity.

[b] The sample sizes are slightly different for different outcomes due to missing values.

[†] Reference group for comparisons

[*] Significantly different than the reference group (P < 0.05).