



# What factors are associated with perceived disease onset in patients with hip and knee osteoarthritis?<sup>☆</sup>

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## ABSTRACT

**Introduction:** Newly symptomatic osteoarthritis (OA) is often misinterpreted as new pathology or injury, which is associated with pain intensity and incapability.

**Methods:** Adult patients with hip and knee OA completed measures of catastrophic thinking, depression, capability, symptom duration, and perceived injury.

**Results:** Symptom duration was associated with OA grade and symptoms of depression. Perceived injury was common (31%) and associated with men and knee arthritis. Capability was associated with misinterpretation of symptoms and the work status ‘other,’ but not radiographic severity.

**Conclusions:** Misinterpretation of OA symptoms is common and has a greater influence on capability than radiographic grade of pathophysiology.

## 1. Introduction

The aging musculoskeletal system undergoes gradual physiological changes such as loss of articular cartilage in the hip and knee.<sup>1–3</sup> Although pathology develops slowly and gradually over several years, osteoarthritis (OA) that is newly symptomatic is often misinterpreted as a new problem. For instance, one study of gradual onset upper extremity illnesses found that 68% of patients misperceive the condition as having started within a year when the symptoms were first noticed.<sup>4</sup> Media, marketing, personal experiences, and other factors can reinforce such unhealthy biases.<sup>5</sup> Patients who recognize symptoms of OA as a normal part of the aging process can have a healthier identity than patients who feel their symptoms are caused by an injury, a common misconception which may be associated with greater incapability.<sup>6–8</sup> Furthermore, such misconceptions might increase the risk that a patient makes treatment decisions that are not consistent with what matters most to them (their values).<sup>9</sup>

In light of the potential impact of misconceptions about the cause and misinterpretation of perceived disease onset among patients with OA, we asked: 1) What factors are independently associated with patient perception of disease onset (symptom onset in months) related to hip and knee OA? 2) What factors are associated with the belief that

osteoarthritis is due to an injury rather than age-related? 3) What factors are associated with the magnitude of capability?

## 2. Materials and methods

### 2.1. Study design and setting

After institutional review board approval, new and return English-speaking patients aged 40 to 89 years-old with atraumatic hip or knee OA visiting urban hip and knee arthroplasty specialists were invited to participate in a cross-sectional study over a 9-month period. To avoid repeat enrollment of returning patients, if the patient’s previous or first office visit was after enrollment started, then the patient was not enrolled in the study.

Participants were approached before or after their visit with the clinician and invited to complete questionnaires. Completion of the questionnaire represented implied informed consent. Questionnaires were completed in a private exam room on an electronic tablet using the Research Electronic Data Capture (REDCap; Nashville, TN) secure web-based application.

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## 2.2. Study population

One hundred and forty-eight people started the questionnaires, but 29 patients (20%) were excluded because they left before completing at least 60% of the questionnaires or there were lapses in enroller-entered details after completion of the visit, leaving 119 for analysis. These logistical lapses occurred at random. The study sample included 80 (67%) women and 39 (33%) men with a mean age of 62 (Standard Deviation: 9.9 years; Table 1). Ninety-one patients (76%) had knee OA; 69% of patients believed their symptoms were due to age-related changes. The median symptom onset was 18 months (Interquartile range: 8 to 60).

## 2.3. Measures

Participants completed a demographic survey, mental health questionnaires, and a measure of capability. Demographics included age, sex, level of education, work status, yearly household income, and insurance status. People were asked how many months ago they first noticed symptoms, whether the symptoms were in the hip or knee, and if the symptoms were the result of an injury or age-related changes.

The mental health questionnaires included the two question version of the Patient Health Questionnaire (PHQ-2) to measure symptoms of depression,<sup>10,11</sup> the two question version of the Generalized Anxiety Disorder (GAD-2) to measure symptoms of anxiety,<sup>12</sup> and the 4 question version of the Pain Catastrophizing Scale (PCS-4) to measure the

cognitive bias of worst-case thinking regarding nociception.<sup>8,13</sup> For each measure, higher numbers indicate greater symptom intensity.

The magnitude of capability was measured using the Patient Reported Outcomes Measurement Information System Physical Function upper extremity Computer Adaptive Test (PROMIS PF CAT).<sup>14–16</sup> A score of 50 is average for the United States population, with each 10 points above or below 50 representing a standard deviation from the mean. Higher scores indicate greater capability.

On completion of the survey, the researcher recorded the radiographic severity of OA according to the Kellgren Lawrence (KL) classification as applied by the clinician.<sup>17</sup> Grade 1 is doubtful joint space narrowing with possible osteophyte lipping; Grade 2 is definite osteophytes and possible narrowing of joint space; Grade 3 is multiple osteophytes, definite narrowing of the joint space, with possible deformity of bone; and Grade 4 is large osteophytes, with marked joint space narrowing, severe subchondral sclerosis, and deformity of bone contour.<sup>17</sup>

## 2.4. Statistical analysis

Categorical variables were presented as frequencies and percentages. For continuous variables, we calculated the mean and standard deviations for variables with a normal distribution, while the median and interquartile range was used for variables with a nonparametric distribution. We performed bivariate analyses to seek factors associated with the duration of symptoms, accounting for gender, education level, work status, income, insurance, provocation (i.e. age-related compared to injury-related), joint involved (i.e. hip or knee), age, GAD-2, PHQ-2, PCS-4, PSEQ-2, PROMIS PF CAT, and KL grade. We calculated Spearman rank-order correlations for continuous variables, and we used Mann-Whitney U and Kruskal-Wallis tests for categorical variables, where appropriate. All variables with a *P*-value below 0.10 were moved to negative binomial regression analysis. We used the variance inflation factor (VIF) and correlation matrices to detect multicollinearity between independent variables. Since there were strong bivariate associations between measures of mental health such as the GAD-2, the PHQ-2, and the PSC-4, colinear variables were dropped from the model. We used the Akaike Information Criterion (AIC) to assess candidate variables and to construct a model with the lowest prediction error and the best fit.<sup>18</sup> For the secondary hypotheses, we sought factors associated with the PROMIS Physical Function CAT score and perceiving injury as the cause of symptoms. All variables with a *P*-value <0.10 in bivariate analysis were moved to multivariable linear and logistic regression models respectively to seek factors associated with the PROMIS Physical Function and the perception of symptoms being due to an injury. The KL Grade was entered in the multivariable model for PROMIS PF regardless of bivariate significance because of the assumption that OA grade would impact symptom severity. We reported the Regression Coefficients (RC), Odds Ratios (OR), 95% Confidence Interval (CI), and *P*-value. *P*-values below 0.05 were considered statistically significant.

An a priori sample size calculation determined that 102 patients provide 80% statistical power, with  $\alpha$  set at 0.05, for a regression with ten predictors if the complete model would account for 15% of the variability in the duration of symptoms. We aimed to enroll 120 patients to account for missing or incomplete questionnaires.

## 3. Results

In bivariate analysis, a longer duration of symptoms was associated with annual income, public or no insurance, greater symptoms of anxiety, greater symptoms of depression, greater catastrophic thinking, and higher KL Grade of OA (Table 2). In multivariable analysis, longer duration of symptoms was associated with greater symptoms of depression and higher KL Grade for OA (Table 3).

In bivariate analysis, perceived injury was associated with men, knee symptoms, and younger age (Table 4). In multivariable logistic

**Table 1**  
Patient demographics.

Variables	Value
N	119
Age	62 ± 9.9
Gender	
Women	80 (67%)
Men	39 (33%)
Education	
High school or less	45 (38%)
2-year college	19 (16%)
4-year college	31 (26%)
Post graduate degree	24 (20%)
Work status	
Employed	43 (36%)
Retired	44 (37%)
Other	32 (27%)
Annual household income	
<\$30,000	47 (40%)
\$30,000-\$99,999	43 (36%)
>\$100,000	29 (24%)
Insurance	
Private	45 (38%)
Public or no insurance	74 (62%)
GAD-2	2 (0–3)
PHQ-2	1 (0–3)
PCS-4	4 (2–7)
PSEQ-2	6 (4–10)
PROMIS Physical Function (t-score)	38 ± 6.9
Duration of symptoms (months)	18 (8–60)
Perceived injury	37 (31%)
Joint	
Knee	91 (76%)
Hip	28 (24%)
Kellgren-Lawrence grade	
1	25 (21%)
2	24 (20%)
3	30 (25%)
4	40 (34%)

Continuous variables as mean ± standard deviation or median (interquartile range [IQR]); discrete variables as percentage (number). GAD-2 = Generalized Anxiety Disorder 2-item; PHQ-2 = Patient Health Questionnaire 2-item; PCS-4 = Pain Catastrophizing Scale 4-item; PSEQ-2 = Pain Self-Efficacy Questionnaire 2-item.

**Table 2**

Bivariate analysis of factors associated with the duration of symptoms in months.

Categorical variables	Median (IQR)	P value
Gender		0.46
Women	18 (6–54)	
Men	24 (9–82)	
Education		0.23
High school or less	18 (11–72)	
2-year college	24 (6–36)	
4-year college	36 (12–60)	
Post graduate degree	12 (5.5–30)	
Work status		0.21
Employed	12 (6–48)	
Retired	24 (12–54)	
Other	36 (9–77)	
Annual household income		0.069
<\$30,000	36 (9–82)	
\$30,000–\$99,999	24 (12–48)	
>\$100,000	11 (4–36)	
Insurance		0.030
Private	12 (6–36)	
Public or no insurance	24 (11–60)	
Perceived provocation		0.79
Injury	16 (6–100)	
Age-related changes	24 (9–48)	
Joint		0.79
Knee	24 (6–60)	
Hip	12 (10–48)	
Continuous variables	Spearman rank correlation coefficient (ρ)	
Age	0.032	0.73
GAD-2	0.21	0.020
PHQ-2	0.29	0.002
PCS-4	0.32	<0.001
PSEQ-2	−0.12	0.20
PROMIS Physical Function (t-score)	−0.26	0.005
Kellgren-Lawrence grade	0.30	<0.001

Continuous variables as median (IQR = interquartile range). All variables with  $P < 0.10$  were moved to multivariable analysis. GAD-2 = Generalized Anxiety Disorder 2-item; PHQ-2 = Patient Health Questionnaire 2-item; PCS-4= Pain Catastrophizing Scale 4-item; PSEQ-2 = Pain Self-Efficacy Questionnaire 2-item.

**Table 3**

Multivariable negative binomial regression analysis of factors associated with the duration of symptoms in months.

Variables	Regression coefficient (95% Confidence Interval)	Standard error	P value	Pseudo R <sup>2</sup>
Annual household income				0.021
<\$30,000	<i>reference value</i>			
\$30,000–\$99,999	−0.0030 (−0.52 to 0.51)	0.26	0.99	
>\$100,000	−0.51 (−1.1 to 0.043)	0.28	0.071	
Insurance				
Public or no insurance	<i>reference value</i>			
Private	−0.20 (−0.64 to 0.24)	0.22	0.38	
Kellgren-Lawrence grade	0.22 (0.054–0.39)	0.085	0.009	
PHQ-2†	0.18 (0.047–0.31)	0.067	0.008	

**Bold** indicates statistical significance,  $P < 0.05$ . PHQ-2 = Patient Health Questionnaire 2-item. † The GAD-2, PCS-4, and PROMIS Physical Function were omitted due to collinearity with PHQ-2 (Spearman  $\rho > 0.5$ ).

**Table 4**

Bivariate analysis of factors associated with perceived injury.

Categorical variables	Injury (N = 37)	Age-related (N = 82)	P value
Gender			0.006
Women	18 (49)	62 (76)	
Men	19 (51)	20 (24)	
Education			0.19
High school or less	19 (51)	26 (32)	
2-year college	4 (11)	15 (18)	
4-year college	9 (24)	22 (27)	
Post graduate degree	5 (14)	19 (23)	
Work status			0.14
Employed	17 (46)	26 (32)	
Retired	9 (24)	35 (43)	
Other	11 (30)	21 (26)	
Annual household income			0.89
<\$30,000	15 (41)	32 (39)	
\$30,000–\$99,999	14 (38)	29 (35)	
>\$100,000	8 (22)	21 (26)	
Insurance			0.31
Private	11 (30)	34 (41)	
Public or no insurance	26 (70)	48 (59)	
Joint			0.009
Knee	34 (92)	57 (70)	
Hip	3 (8)	25 (30)	
Age	60 ± 11	63 ± 9.3	0.065
Duration of symptoms	16 (6–100)	24 (9–48)	0.79
GAD-2	1 (0–4)	2 (0–3)	0.72
PHQ-2	2 (0–3)	1 (0–2)	0.40
PCS-4	4 (2–6)	4 (2–7)	0.50
PSEQ-2	7 (4–10)	6 (4–10)	0.84
PROMIS Physical Function (t-score)	38 ± 7.3	38 ± 6.7	0.74
Kellgren-Lawrence grade	3 (1–4)	3 (2–4)	0.90

Continuous variables as mean ± standard deviation or median (interquartile range [IQR]); discrete variables as percentage (number). All variables with  $P < 0.10$  were moved to multivariable analysis. GAD-2 = Generalized Anxiety Disorder 2-item; PHQ-2 = Patient Health Questionnaire 2-item; PCS-4= Pain Catastrophizing Scale 4-item; PSEQ-2 = Pain Self-Efficacy Questionnaire 2-item.

**Table 5**

Multivariable logistic regression analysis of factors associated with perceived injury.

Variables	Odds Ratio (95% Confidence Interval)	Standard error	P value	Pseudo R <sup>2</sup>
Age	0.96 (0.92–1.0)	0.022	0.11	0.12
Gender				
Women	<i>reference value</i>			
Men	3.4 (1.4–8.1)	1.5	0.005	
Joint				
Knee	<i>reference value</i>			
Hip	0.25 (0.067–0.92)	0.17	0.037	

**Bold** indicates statistical significance,  $P < 0.05$ .

regression, perceived injury was independently associated with men and knee symptoms (Table 5).

In bivariate analysis, less capability was associated with women, education level, work status, annual household income, public or no insurance, duration of symptoms, greater symptoms of anxiety, greater symptoms of depression, greater catastrophic thinking, and lower self-efficacy in response to pain (Table 6). In multivariable analysis, lower capability was associated with greater catastrophic thinking and other than employed work status, but not with radiographic severity of arthritis (Table 7).

#### 4. Discussion

Hip and knee OA develop gradually and are often initially noticed at

**Table 6**  
Bivariate analysis of factors associated with the PROMIS Physical Function score.

Categorical variables	Mean ± SD	P value
Gender		<b>0.054</b>
Women	37 ± 6.7	
Men	40 ± 6.9	
Education		<b>0.001</b>
High school or less	36 ± 5.7	
2-year college	36 ± 7.2	
4-year college	40 ± 7.5	
Post graduate degree	41 ± 5.9	
Work status		<b>&lt;0.001</b>
Employed	41 ± 6.2	
Retired	38 ± 7.0	
Other	33 ± 5.1	
Annual household income		<b>&lt;0.001</b>
<\$30,000	35 ± 6.1	
\$30,000-\$99,999	39 ± 5.5	
>\$100,000	41 ± 7.9	
Insurance		<b>0.009</b>
Private	40 ± 7.0	
Public or no insurance	37 ± 6.5	
Symptom onset		0.10
Sudden	40 ± 8.1	
Gradual	37 ± 6.3	
Perceived provocation		0.74
Injury	38 ± 6.7	
Age-related changes	38 ± 7.3	
Joint		0.16
Knee	38 ± 6.6	
Hip	36 ± 7.4	
Continuous variables	Correlation coefficient	P value
Age (r)	0.064	0.49
Duration of symptoms (ρ)	-0.26	<b>0.005</b>
GAD-2 (ρ)	-0.22	<b>0.014</b>
PHQ-2 (ρ)	-0.50	<b>&lt;0.001</b>
PCS-4 (ρ)	-0.52	<b>&lt;0.001</b>
PSEQ-2 (ρ)	0.70	<b>&lt;0.001</b>
Kellgren-Lawrence grade (ρ)	-0.080	0.39

Continuous variables as median (IQR = interquartile range). Pearson correlation indicated by r; Spearman correlation indicated by ρ. All variables with **P < 0.10** were moved to multivariable analysis. GAD-2 = Generalized Anxiety Disorder 2-item; PHQ-2 = Patient Health Questionnaire 2-item; PCS-4 = Pain Catastrophizing Scale 4-item; PSEQ-2 = Pain Self-Efficacy Questionnaire 2-item.

a relatively advanced stage.<sup>19,20</sup> When symptoms are first noticed, the problem might seem new, and can be misperceived as an injury.<sup>4</sup> Such misperceptions could affect symptom intensity and decision-making.<sup>21</sup> This study found a relatively short perceived duration of symptoms among people with relatively advanced OA, and symptoms were frequently misinterpreted as an injury. Lower capability was related to common misconceptions (cognitive biases) regarding pain, but not radiographic disease severity.

Our study had several limitations. First, the impact of mental health on capability may be underestimated due to the tendency of people to avoid answering mental health questionnaires honestly (seen as floor effects), perhaps due to the social stigma regarding mental health and perhaps the desire to be taken seriously.<sup>22,23</sup> Second, the generalizability of our findings may be limited by the fact that the majority of our patients were white and had little variation in socioeconomic status. We encourage additional study in more diverse population, and our hunch is that the findings will be relatively consistent. Third, we had more incomplete records than typical for our studies due to communication errors between clinicians and researchers. These errors led to patients leaving the office before completing the questionnaires. The errors occurred at random, and we do not believe they influenced the results. Fourth, our planned statistical analysis did not anticipate the notable interactions (collinearity) between the behavioral health questionnaires and some of the demographics (work status, income, and education). When all factors were included in multivariable models using the enter

**Table 7**  
Multivariable linear regression analysis of factors associated with the PROMIS Physical Function score.

Variables	Regression coefficient (95% Confidence Interval)	Standard error	P value	Partial R <sup>2</sup>
Gender				
Women	<i>reference value</i>			
Men	1.6 (-0.69 to 3.9)	1.2	0.17	0.017
Insurance				
Public or no insurance	<i>reference value</i>			
Private	1.1 (-1.3 to 3.4)	1.2	0.38	0.0071
Work status*				
Employed	<i>reference value</i>			
Retired	-2.8 (-5.5 to -0.13)	1.3	<b>0.040</b>	0.038
Other	-4.3 (-7.3 to -1.4)	1.5	<b>0.005</b>	0.070
Duration of symptoms	-0.0044 (-0.024 to 0.015)	0.0097	0.66	0.0018
PCS-4†	-1.1 (-1.5 to -0.59)	0.24	<b>&lt;0.001</b>	0.15
Kellgren-Lawrence grade	0.099 (-0.84 to 1.0)	0.48	0.84	0.00039

**Bold** indicates statistical significance, *P* < 0.05. PCS-4 = Pain Catastrophizing Scale 4-item. \*The variables ‘Annual household income’ and ‘Education’ were omitted because they were associated with ‘Work status’. † The GAD-2, PHQ-2, PSEQ-2, and PROMIS Physical Function were omitted due to collinearity with PCS-4 (Spearman ρ > 0.40).

method, we recognized the problem and switched to a backward elimination technique to avoid interaction between the independent variables. Fifth, people who present with knee osteoarthritis years after a complete Anterior Cruciate Ligament (ACL) rupture or after a tibial plateau fracture may be right that their OA symptoms are caused by a prior injury, but this could not be accounted for. However, we expect that the majority advanced knee OA is not due to injury and represents misinterpretation of symptoms. Lastly, there may be untracked confounders that we did not account for. For instance, it is possible that men are more likely to be working in labor occupations, but we did not account for occupation.

The finding that longer duration of symptoms is independently associated with greater symptoms of depression in addition to more advanced radiographic arthritis emphasizes the importance of care strategies based in the biopsychosocial model of human illness.<sup>24</sup> Perhaps people with better mental health are more adaptive to age-appropriate changes in the knee or hip for longer. That is what we see in the population data of Kim and colleagues,<sup>20</sup> as they found that 1) most people over age 65 have some knee arthritis; 2) less than half the people with KL grade 4, advanced knee arthritis have sufficient symptoms and limitations to qualify for a diagnosis of symptomatic knee arthritis (indicating that even severe OA is generally accommodated); and 3) symptoms of depression had a strong influence on symptoms and limitations, particularly among people with moderate radiographic knee arthritis.

The observation that nearly a third of patients misinterpret OA as an injury, more so in the knee, emphasizes the importance of anticipating common misconceptions about pain. Since humans are programmed to interpret pain as injury, this is to be expected. The degree to which people cognitively fuse with these automatic thoughts (i.e. regard them as facts) seems to affect their explanatory model.<sup>25</sup> An erroneous explanatory model has the potential to contribute to choices inconsistent with one’s values. Health literacy—the degree to which individuals have the capacity to obtain, process and understand basic health information needed to make appropriate health decisions—likely has a strong bidirectional interaction with awareness of the human mind’s tendency toward cognitive biases and cognitive errors and development of



appropriate debiasing strategies.<sup>26–28</sup> Orthopedic surgeons can anticipate misconceptions based on common cognitive biases regarding pain and practice communication strategies to help guide people to more accurate, more enabling, and healthier interpretation of symptoms.

The observation that lower capability is associated with cognitive bias regarding pain (catastrophic or worst-case thinking) and not with KL grade of radiographic OA is consistent with a growing body of evidence that emphasizes the importance of the biopsychosocial model.<sup>20,24,29–33</sup> As mentioned, population-based studies show that pathology corresponds with symptom intensity and capability primarily at the most severe grades of knee OA, with less correspondence and notable influence of mental health at lesser grades of OA.<sup>20,24</sup> Studies of people that seek care for OA address the subset of the population that are sufficiently unsettled to seek care. Among people who are unsettled there may be even less correspondence with radiographic pathology and among population-based studies as seen in this study and also studies of people presenting to a specialist for care of trapeziometacarpal OA.<sup>34,35</sup> It is quite notable that the KL grade of arthritis was not associated with capability when accounting for other factors, and this finding reemphasizes the importance of the biopsychosocial paradigm.

The observation that misinterpretation of the duration of disease and its cause is common reinforces the importance of comprehensive, whole-person, strategies for improving health based on the biopsychosocial model of human illness. Surgeons and their teams can measure symptoms of depression and misinterpretation of pain, and they can also look for the verbal and non-verbal signs of such mental health opportunities.<sup>36,37</sup> Practiced communication strategies and readily available mental and social health expertise can help ensure treatment that addresses the most favorable opportunities for improving health. Our findings suggest a series of misperceptions related to the experience of OA. Orthopedic surgeons can anticipate, identify, and gently and incrementally reorient such misperceptions to achieve the outcomes that matter to patients.<sup>38,39</sup> These processes can be embedded in the interaction and facilitated by planned and practiced communications strategies.

#### Declaration of competing interest

KF, HM, TC, PJ, and KK certify that they have no commercial associations (eg, consultancies, stock ownership, equity interest, patent/licensing arrangements, etc) that might pose a conflict of interest in connection with the submitted article. One of the authors (DR) certifies that he, or a member of his immediate family, has or may receive payment or benefits from Skeletal Dynamics (USD less than 100,000), Wright Medical for elbow implants (USD less than 10,000), Deputy Editor for Clinical Orthopaedics and Related Research, Universities and Hospitals, and Lawyers outside of the submitted work.

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