Pain and Disability in Patients with Osteoarthritis of Hip or Knee: The Relationship with Articular, Kinesiological, and Psychological Characteristics

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ABSTRACT. ***Objective.*** To determine to what extent articular, kinesiological, and psychological factors each contribute to pain and disability in patients with osteoarthritis (OA), after controlling for other factors.

Methods. Cross sectional study among 200 patients with OA of the hip or knee. Dependent variables include pain (visual analog scale), self-reported disability (questionnaire), and observed disability (performance of standardized tasks). Independent variables include joint degeneration (radiographs), muscle strength (dynamometer), range of joint motion (goniometer), pain coping (behavioral and cognitive strategies), and psychological well being (depression, anxiety, cheerfulness). Multiple regression analysis was used.

Results. Pain was found to be associated with muscle weakness and pain coping ($p < 0.05$). Disability was associated with muscle weakness, range of joint motion, pain, pain coping, and psychological well being (all $p < 0.05$). Both pain and disability were most strongly associated with kinesiological characteristics and pain coping.

Conclusion. After controlling for the other characteristics, kinesiological and psychological characteristics in patients with OA are each associated with disability. The association with pain is less clear. Future research on mechanisms underlying these associations is warranted. (J Rheumatol 1998;25:125–33)

Key Indexing Terms:
PAIN DISABILITY OSTEOARTHRITIS

Pain and disability are major symptoms in patients with osteoarthritis (OA)[1]. To a certain extent, these symptoms are accounted for by articular degeneration; radiographically assessed degeneration of cartilage and bone is associated with pain and disability, but it appears that the association is rather weak. This conclusion was drawn in a review of 17 studies published before 1990[2]; studies published subsequently have confirmed this conclusion[3–6]. Thus, it appears that the status of the joint is not a sufficient explanation for pain and disability in patients with OA. Additional explanations can be sought in a complex of factors, presumably associated with the development of pain and disability in patients with OA[2,7,8]. These factors can be classified as kinesiological factors (e.g., muscle weakness) and psychological factors (e.g., pain coping).

With regard to kinesiological factors, muscle weakness has been found to be associated with both pain and disability in patients with OA. This association has been observed in 4 reviewed studies[2] and 2 subsequent studies[4,5]. The most likely explanation is muscle weakness resulting in unstable joints: mechanical stress on unstable joints leads to strain in innervated tissues, which may cause pain and disability. However, all studies on muscle weakness — except two[4,5] — failed to control for the extent of articular degeneration. Thus, there is only limited evidence that muscle weakness contributes to pain and disability, after controlling for articular degeneration. The same criticism applies to the studies on range of joint motion. Disability has been found to be associated with restricted range of joint motion[2], but the studies reporting this association failed to control for articular degeneration. Therefore, it is not known whether range of joint motion accounts for disability after controlling for articular degeneration.

With regard to psychological factors, pain and disability in patients with OA have been found to be associated with coping style, self-efficacy beliefs, and negative affect[2,9].

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Supported by a grant from the Dutch Fund of Investigative Medicine from the Dutch Health Insurance Council (OG92.066).

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Submitted November 26, 1996 revision accepted July 11, 1997.

Most of these studies controlled for the extent of articular degeneration, but not for kinesiological factors. Psychological factors are reported to affect symptoms in patients with OA by way of muscle weakness[10]. Negative affect is thought to enhance patients' tendency to avoid pain related activities: avoidance causes muscle weakness and thus pain and disability. Psychological factors may operate in other ways as well, but it is not known whether psychological factors contribute to pain and disability in patients with OA after controlling for kinesiological factors.

It can be concluded that pain and disability in patients with OA have been shown to be associated with articular, kinesiological, and psychological characteristics. However, it is not clear to what extent each of these factors separately contributes to pain and disability, after controlling for the other factors. Our goal was to determine the most economical set of predictors for pain and disability in patients with OA.

MATERIALS AND METHODS

Patients. Patients were selected by general practitioners (GP) to participate in a randomized clinical trial into the effectiveness of exercise therapy in patients with OA. These patients were visiting the GP on their own initiative because of complaints of OA. Inclusion criteria were OA of the knee or hip according to the clinical criteria of the American College of Rheumatology[11,12]. Exclusion criteria were other pathology explaining the complaints, complaints in less than 10 of the last 30 days, treatment for these complaints with exercise therapy in the preceding 6 months, under 40 or over 85 years of age, indication for hip or knee replacement, contraindication for exercise therapy, contraindications for analgesics or nonsteroidal antiinflammatory drugs (NSAID), and inability to understand the Dutch language. After selection by their GP, patients' eligibility was checked by a specially trained GP Research Fellow. The data in this study were collected at baseline, i.e., when patients entered the trial.

GP selected 216 patients; 9 patients did not consent to participation and 7 patients were excluded because they did not meet selection criteria, which resulted in 200 patients remaining. Patients with OA of the hip and OA of the knee were analyzed separately as reported below. Patients with OA of both hip and knee were included in both the hip group and the knee group. Patients for whom no radiographs were available were excluded. This resulted in 73 patients with hip OA (including 6 patients with knee OA as well) and 112 patients with knee OA (including 7 patients with hip OA as well; due to missing radiographs, there is a difference between the hip group and the knee group in the number of patients with a double diagnosis).

Radiographs. The radiographs were taken in local hospitals according to a standard protocol. In hip patients a plain pelvis view was taken with patients in supine position. In knee patients weight bearing anteroposterior radiographs of both knees were taken and lateral radiographs with 60° flexion were taken while patients were recumbent of both knees. All radiographs were evaluated for the presence of features of OA by one author (JAML), using grading scales for individual radiographic features[13]. Readings of each hip included 9 scores for superior, medial, and axial joint space narrowing and for osteophytes, subchondral sclerosis, and cyst formation in both acetabulum and femur. Scores were assigned on a 0–3 scale. For the knee radiographs, the medial, lateral, and patellofemoral compartments of each knee were scored for joint space narrowing, osteophytes, subchondral sclerosis, and cyst formation on a 0–3 scale. Scores were added across features and for left and right joint to obtain an overall value of the radiological status of the hip or knee[4,14,15]. In knee patients, the pattern of knee OA was also analyzed according to the system of Ahlback[16,17]. Three patterns of localization were distinguished (1) isolated patellofemoral OA (PF-OA, sum score PF compartment ≥ 1 and sum score medial and lateral compartments = 0), (2) isolated tibiofemoral OA (TF-OA, sum score medial and lateral compartment ≥ 1 and sum score PF compartment = 0), and (3) combined pattern.

Pain and disability. Patients rated their pain on a visual analog scale (0–100 mm), rating pain in the past week. In addition, present pain and pain in the past month were assessed. Because these pain ratings were highly intercorrelated, analyses were restricted to pain in the past week.

Both observed and self-reported disability were assessed. Self-reported disability is of utmost importance to the patients; but because subjective bias might cause deviations, observed disability was assessed also. Observed disability was determined by studying videos of the patients' performance of a series of standardized tasks using an adaptation of the method described by Keefe[18,19]. Both movement times and quality of performance were assessed. A total score was calculated based on 5 measures: 5 m walking time, stand-to-sit time, reclining time, and the levels of guarding and rigidity during the performance of the tasks (see data analysis). Self-reported disability was assessed with the IRGL questionnaire (Invloed van Reuma op Gezondheid en Leefwijze: Influence of Rheumatic Disease on General Health and Lifestyle)[20]. This is a Dutch adaptation of the Arthritis Impact Measurement Scales. From the IRGL questionnaire, the subscale "mobility" was used, which consists of 2 items concerning disability in general and 5 items concerning disability in climbing stairs, cycling, and walking.

Muscle strength and range of motion. Isometric muscle strength was measured with the MicroFet (Hoggan Health Industries, Draper, Utah, USA), a hand held dynamometer[21]. A protocol was used to standardize the measurements. Tests were used in which the research assistant holds the dynamometer steady while the patient exerts a maximal force against it[22]. Patients were asked to gradually build their force in 2 seconds to a maximal voluntary effort and to maintain this effort during 3 seconds. Starting positions were as in Kendall and Kendall[23]. Muscle strength (in Newtons) was measured bilaterally for 8 muscle actions. For the hip, the extension, flexion, abduction, adduction, endorotation, and exorotation were measured. For the knee, flexion and extension were measured. Reference values for muscle strength were obtained from 10 healthy subjects (5 male, 5 female subjects, mean age 30.8 yrs ± 8.5). These reference values [mean and standard deviation (SD) in Newton] for the hip were extension 209 ± 45; flexion 258 ± 75; abduction 264 ± 57; adduction 217 ± 60; endorotation 184 ± 23; exorotation 153 ± 39. For the knee, the muscle strength reference values were flexion 166 ± 39; extension 222 ± 49.

Assisted active range of joint motion (in degrees) was measured with a goniometer, according to Norkin and White[24]. These measurements were also standardized in the measurement protocol. Range of motion around the hip was measured by assessing extension, flexion, abduction, adduction, endorotation, and exorotation. Range of motion of the knee was measured by assessing flexion and extension.

Muscle strength and range of joint motion were assessed by 2 research assistants, both experienced physical therapists who had been intensively trained to perform these measurements in a standardized way. Followup training sessions were held to maximize standardization. Each patient was tested by a single research assistant. Interrater reliability of the physical examination was satisfactory. The mean of intraclass correlation coefficients was 0.78 for muscle strength measurements (range 0.60–0.93) and 0.68 for range of motion measurements (range 0.39–0.90).

Psychological characteristics. Pain coping behavior was measured with the Pain Coping Inventory[25]. This inventory consists of 6 subscales, assessing both behavioral and cognitive coping strategies. A high score reflects a high use of the specific strategy when in pain. In addition, an adaptation for patients with OA of the Fear-Avoidance Beliefs Questionnaire was used[26]. This scale measures the extent to which patients believe physical activity affects their pain. Psychological well being was assessed on 3 scales of the IRGL questionnaire: anxiety, depression, and cheerfulness[20] (see above). The higher the score, the more this aspect applies to a patient.

Medication. Patients reported on their use of medication in the last 7 days before inclusion in the study. It was determined whether or not the patient had used paracetamol and/or NSAID.

Other variables. Patients reported the duration of complaints (in weeks). Body mass and height were assessed by the research assistants; body mass index was calculated as body mass/height^2.

Data reduction and analysis. For observed disability an overall score was composed. The scores on movement times were transformed into 10 categories to correct for skewed distributions. Subsequently, Z scores were computed for every measurement to avoid weighting problems due to differences in score ranges. Z scores were then added to obtain an overall score. The resulting overall score was standardized (by division through the SD of the overall score) to render a score with a mean of zero and a standard deviation of one. The internal consistency of the constructed overall score for observed disability was good ($\alpha = 0.84$).

To facilitate interpretation, IRGL ability scores were recoded into disability scores by reversing the sign. Thus, a high score indicates disability, for both observed and self-reported disability.

Muscle strength data were normalized to body mass, by dividing the raw scores by body mass[27]. Next, Z scores were computed and added for left and right to obtain one overall score: a patient score, based on 12 tests of the hip (6 muscle actions, both left and right) and 4 tests of the knee (2 muscle actions, both left and right). This overall score was divided by its SD to enhance comparability. For range of joint motion data, a comparable procedure was followed, i.e., calculation of Z scores and construction of one overall score.

Our analyses were repeated using data on OA joints only. These analyses yielded highly similar results. Because pain and disability concern the functioning of the entire patient, the reported analyses were based on the overall score of radiological status, muscle strength, and range of joint motion (instead of data on OA joints only).

With some patients (maximum 3%) data on the following variables were missing: pain coping, IRGL scales, duration of complaints, and muscle strength. Using the procedure of mean substitution, these patients were included in the analyses.

Bivariate relationships are expressed in Pearson's product moment correlation coefficient. Exceptions are the relationships with separate radiological scores and duration of complaints (Spearman's rank order correlation coefficient) and with medication and sex (eta). Multiple regression analyses were performed to determine the most economical set of predictors for pain and disability after controlling for other characteristics. Stepwise analyses were performed with the characteristics displayed in Table 2[28]. Total scores were used for radiological status, muscle strength, and range of motion. Pain was used as an independent variable in analyses of disability. Beta values of the variables in the final regression equations are reported as the outcome of regression analyses. The significance level was set at 0.05. An exception is the significance level for exclusion from the regression equation: the "exit α" was 0.10. Analyses were performed during SPSS/PC+ version 5.0.

RESULTS

Characteristics of patients. In Table 1 clinical characteristics are presented for both hip patients and knee patients. The patients were on average 68 years old and most were women. The median duration of complaints was longer than one year. About half of the patients reported having taken paracetamol in the past week and about 30% had taken NSAID. The radiological scores were low, representing mild articular degeneration. In knee patients, 7.1% was classified as isolated PF OA, 19.6% as isolated PF OA, and 54.5% as combined TF/PF OA (not shown). The average pain scores were just below the midpoint of the scale. Muscle strength of both hip and knee was below reference values (see Materials and Methods). Range of hip motion was below reference values, but range of knee motion was equal to reference values[29]. Patients with OA of both hip and knee OA had similar characteristics (not shown).

The bivariate correlations between articular, kinesiological, psychological, and other variables on the one hand and pain and disability on the other are shown in Table 2. Because of the large number of correlations, only those significant at the 0.01 level are reported. Radiological characteristics showed significant correlations with disability in knee patients. Muscle strength was consistently correlated with pain and disability in both hip and knee patients: patients with weaker muscles showed more pain and disability. There were significant correlations between range of joint motion and disability: patients with smaller range of joint motion were more disabled. Pain was correlated with disability. Both pain coping and psychological well being showed significant correlations with pain and disability; e.g., patients who cope by resting more frequently reported more pain and disability. Older patients were more disabled and, in hip patients, duration of complaints was correlated with pain.

Multivariate analysis. The results of multiple regression analyses with regard to pain are presented in Table 3. The final explained variance (final R^2) was significant in both hip and knee patients. However, the number of variables retained in analyses and the final explained variance, especially in knee patients, was relatively small. Muscle strength was associated with pain in hip but not in knee patients. Pain coping was associated with pain in both hip and knee patients: hip patients who reported high levels of resting and of fear avoidance beliefs experienced more pain; knee patients who reported a high level of retreating reported more pain. In hip patients, a longer duration of complaints was associated with higher pain levels. In knee patients, psychological well being was associated with pain: a low score on cheerfulness was reported by patients with higher pain levels. Articular status, range of motion, and medication use were not associated with pain.

The results of multiple regression analyses with regard to disability are presented in Table 4. The amount of final explained variance in disability (final R^2) was significant, in both hip patients and knee patients. This applies to both observed and self-reported disability.

Muscle strength was associated with disability, in both hip and knee patients: patients with weaker muscles were more disabled. Range of joint motion was also associated with disability: a smaller range of joint motion was associated with more disability, in both hip and knee patients.

Pain was associated with disability, with the exception of observed disability in knee patients. Patients reporting more pain were more disabled. Pain coping was also associated with disability. Hip patients and knee patients who rested

Table 1. Description of patients with OA of the hip or knee.

	Hip, n = 73	Knee, n = 112
Age, yrs	67.7 (8.7)	69.3 (8.1)
% Women	71.2	88.4
Duration of complaints[a], weeks	52 (17–158)	65 (18–342)
Body mass index	27.8 (4.1)	28.4 (3.9)
Medication past week		
Paracetamol, %	49.3	44.6
NSAID, %	28.8	27.7
Radiological status		
1. Joint space narrowing, 0–18[a]	2.5 (3.2)	1.9 (2.2)
2. Osteophytes, 0–12 or 0–18[a,b]	2.6 (2.0)	2.3 (2.6)
3. Sclerosis, 0–12 or 0–18[a,b]	0.2 (0.8)	0.1 (0.4)
4. Cyst formation, 0–12 or 0–18[a,b]	0.7 (1.7)	0.0 (0.0)
Total score, 0–54 or 0–72	6.0 (5.9)	4.3 (4.6)
Pain		
Pain past week, 0–100	39.7 (24.5)	48.3 (27.8)
Observed disability[a]		
1. 5 m walking time, s[a]	4.8 (4.0–5.9)	5.2 (4.5–6.1)
2. Sit time, s[a]	3.4 (3.0–4.1)	3.4 (2.9–4.2)
3. Recline time, s[a]	6.5 (5.0–8.5)	6.5 (5.6–9.0)
4. Guarding, 0–1	0.5 (0.5)	0.6 (0.5)
5. Rigidity, 0–1	0.4 (0.4)	0.3 (0.4)
Self-reported disability (mobility), 7–28	–21.0 (5.0)	–19.7 (5.9)
Muscle strength[c], Newton		
1. Flexion hip	168.4 (52.8)	153.7 (52.6)
2. Extension hip	115.8 (47.9)	97.6 (48.3)
3. Abduction hip	168.1 (50.8)	164.1 (59.1)
4. Adduction hip	145.0 (54.8)	125.5 (51.4)
5. Endorotation hip	128.3 (43.5)	114.4 (40.8)
6. Exorotation hip	102.6 (29.8)	94.6 (31.7)
7. Flexion knee	92.6 (30.9)	85.0 (29.9)
8. Extension knee	162.3 (47.6)	152.0 (47.5)
Range of motion[c], degrees		
1. Flexion hip	111.4 (12.0)	117.8 (9.6)
2. Extension hip	1.7 (6.7)	2.2 (7.4)
3. Abduction hip	15.6 (5.0)	18.7 (6.4)
4. Adduction hip	11.5 (3.9)	12.1 (3.7)
5. Endorotation hip	24.8 (8.6)	31.3 (7.8)
6. Exorotation hip	32.3 (8.7)	35.5 (8.0)
7. Flexion knee	138.5 (7.4)	134.3 (10.5)
8. Extension knee	1.4 (4.0)	–0.7 (4.8)
Pain coping[d]		
1. Pain transformation, 4–16	9.1 (2.3)	9.0 (2.8)
2. Distraction, 5–20	11.4 (3.4)	10.9 (3.1)
3. Reducing demands, 3–12	6.4 (2.0)	6.6 (2.1)
4. Retreating, 7–28	11.0 (3.4)	11.2 (3.9)
5. Worrying, 9–36	16.5 (3.7)	16.4 (4.7)
6. Resting, 5–20	11.5 (3.3)	11.2 (3.1)
Fear avoidance beliefs about physical activity, 0–24	13.5 (5.8)	14.7 (6.5)
Psychological well-being, IRGL[e]		
1. Anxiety, 10–40	17.7 (6.0)	18.6 (5.8)
2. Depression, 0–24	4.3 (2.7)	4.9 (3.8)
3. Cheerfulness, 0–24	12.1 (4.3)	11.7 (4.7)

Mean (SD) unless otherwise stated.

[a]Median and interquartile ranges.

[b]Ranges differ between hip and knee patients due to a different number of diagnosed compartments (see Materials and Methods).

[c]Total scores are not presented. As a result of standardization, mean and standardization equal zero and one, respectively (see Materials and Methods).

[d]A high score reflects a high use of this strategy when in pain.

[e]A high score reflects that this aspect highly applies.

Table 2. Bivariate correlations of radiological, kinesiological, psychological, and other variables with pain and disability.

	Hip, n = 73 Pain	Observed Disability	Self-reported Disability	Knee, n = 112 Pain	Observed Disability	Self-reported Disability
Radiological status						
1. Joint space narrowing[a]	–0.15	–0.03	0.21	0.26**	0.28**	0.26**
2. Osteophytes[a]	–0.08	0.04	–0.12	0.07	0.13	0.23*
3. Sclerosis[a]	–0.23*	–0.23*	–0.25*	0.02	0.20*	0.14
4. Cyst formation[a]	0.09	0.08	0.07	—	—	—
Total score	–0.17	–0.01	–0.18	0.14	0.24*	0.28*
Muscle strength[b]						
1. Flexion hip	–0.34**	–0.28*	–0.36**	–0.24**	–0.48**	–0.38**
2. Extension hip	–0.32**	–0.50**	–0.38**	–0.26**	–0.36**	–0.37**
3. Abduction hip	–0.31**	–0.40**	–0.46**	–0.21*	–0.34**	–0.39**
4. Adduction hip	–0.30*	–0.41**	–0.38**	–0.21*	–0.43**	–0.41**
5. Endorotation hip	–0.26*	–0.45**	–0.38**	–0.28**	–0.35**	–0.44**
6. Exorotation hip	–0.31**	–0.48**	–0.44**	–0.08	–0.38**	–0.39**
7. Flexion knee	–0.34**	–0.31**	–0.38**	–0.30**	–0.45**	–0.44**
8. Extension knee	–0.34**	–0.45**	–0.43**	–0.24*	–0.39**	–0.38**
Total score	–0.37**	–0.48**	–0.47**	–0.26**	–0.45**	–0.45**
Range of motion						
1. Flexion hip	–0.09	–0.22	–0.17	–0.15	–0.26**	–0.21*
2. Extension hip	–0.20	–0.38**	–0.37**	–0.19*	–0.31**	–0.29**
3. Abduction hip	–0.14	–0.33**	–0.30**	–0.05	–0.39**	–0.23*
4. Adduction hip	–0.08	–0.03	0.07	–0.08	–0.04	–0.14
5. Endorotation hip	0.01	–0.14	0.01	–0.19*	–0.23*	–0.23*
6. Exorotation hip	–0.25*	–0.35**	–0.34**	–0.13	–0.34**	–0.31**
7. Flexion knee	–0.26*	–0.35**	–0.31**	–0.16	–0.27**	–0.31**
8. Extension knee	–0.05	–0.16	–0.17	–0.16	–0.06	–0.24*
Total score	–0.25*	–0.46**	–0.37*	–0.27**	–0.45*	–0.47**
Pain	—	0.46**	0.48**	—	0.33**	0.40**
Pain coping[c]						
1. Pain transformation	0.15	–0.06	0.14	0.27**	0.18	0.22*
2. Distraction	0.17	0.06	0.11	0.25**	0.22*	0.16
3. Reducing demands	0.07	0.31**	0.15	0.21*	0.15	0.22*
4. Retreating	0.29*	0.35**	0.41**	0.39**	0.33**	0.40**
5. Worrying	0.26*	0.26*	0.33**	0.36**	0.40**	0.35**
6. Resting	0.34**	0.38**	0.48**	0.24**	0.44**	0.41**
Fear avoidance beliefs	0.39**	0.34**	0.45**	0.20*	0.22*	0.29**
Psychological well being[d]						
1. Anxiety	0.25*	0.26*	0.39**	0.30**	0.18	0.24**
2. Depression	0.04	–0.03	0.13	0.28**	0.16	0.13
3. Cheerfulness	–0.14	–0.23	–0.28*	–0.26**	–0.26**	–0.30*
Medication						
1. Paracetamol[e]	0.28*	0.19	0.17	0.51*	0.06	0.12
2. NSAID[e]	0.03	0.05	0.15	0.29*	0.20	0.54*
Other						
Age	0.14	0.43**	0.31**	0.00	0.40**	0.21*
Sex[e]	0.17	0.11	0.13	0.24	0.41	0.30
Duration of complaints[a]	0.38**	0.12	0.02	0.18	0.13	0.13

*p ≤ 0.05; **p ≤ 0.01.
[a]Spearman's rank correlation coefficient.
[b]Muscle strength data are normalized to body weight.
[c]A high score reflects a high use of this strategy when in pain.
[d]A high score reflects that this aspect highly applies.
[e]Eta.

frequently were more disabled; hip patients who reduced their demands or had low scores on distraction, and knee patients with high scores on worrying, were more disabled also.

Psychological well being was associated with self-reported disability in hip patients only; anxious patients reported higher levels of disability. Medication use was associated with disability in knee patients only. Finally,

Table 3. Multiple regression analysis: pain.

	Hip, n = 73	Knee, n = 112
Radiological status	—	—
Muscle strength	–0.22*	—
Range of motion	—	—
Pain coping[a]		
Pain transformation	—	—
Distraction	—	—
Reducing demands	—	—
Retreating	—	0.36**
Worrying	—	—
Resting	0.21*	—
Fear Avoidance Beliefs	0.24*	—
Psychological well being[b]		
Anxiety	—	—
Depression	—	—
Cheerfulness	—	–0.21*
Medication		
Paracetamol	—	—
NSAID	—	—
Others		
Age	—	—
Sex	—	—
Duration of complaints[c]	0.31**	—
Final R^2 adjusted	0.32**	0.18**

$*p \leq 0.05$; $**p \leq 0.01$.
[a]A high score reflects a high use of this strategy when in pain.
[b]A high score reflects that this aspect highly applies.
[c]Logarithmic transformation.

older patients, especially hip patients, were more disabled. Articular status was not associated with disability. The exclusion of pain, as a possible intervening variable between radiological status and disability, did not change the association between radiological status and disability (not shown).

DISCUSSION

This study confirms that when taking into account articular, kinesiological, and psychological characteristics, kinesiological and psychological characteristics are separately associated with disability in patients with OA of the hip or knee. This applies to both observed and self-reported disability. The association of kinesiological and psychological characteristics with pain is less pronounced.

Bivariate analyses indicated significant correlations between articular, kinesiological, and psychological characteristics and pain and disability. Because these bivariate analyses do not control for the effect of other characteristics, multivariate analyses were performed. In these multivariate analyses, disability was found to be associated with muscle strength, range of joint motion, pain, pain coping, and psychological well being (in hip patients only); the effect of articular status was not significant. Pain was found to be associated with muscle strength (hip patients only), pain coping, and psychological well being (knee patients only).

Our results confirm earlier observations[2,4] that radiographically assessed joint degeneration is not associated with disability, after controlling for other factors such as muscle strength. Pain could be an intervening variable in the causal chain from articular status to disability. Following this, inclusion of both pain and radiological status in the regression analyses would lead to underestimation of the importance of radiological status for disability. However, exclusion of pain as a predictor for disability did not yield different results; articular status remained absent as a predictor of disability.

Compared to radiological status, decreased muscle strength and range of joint motion are more strongly associated with disability: the standardized regression coefficients ranged from 0.19 to 0.28. These findings add to other observations[2,5,6] in the sense that even after controlling for radiological status, kinesiological factors appear to be associated with disability in patients with OA. Muscle strength and range of motion contributed equally to understanding the level of disability: the standardized regression coefficients were similar. Although no causal conclusions can be drawn from this cross sectional study, this finding is certainly consistent with muscle strength and range of motion being important determinants of disability in patients with OA of the hip and/or knee. Decreased muscle strength could be due to disuse and avoidance of pain related activities. Decreased muscle strength causes disability, either directly or through unstable joints. It should be noted, however, that muscle weakness may also be due to factors other than disuse, e.g., reflex inhibition[30]. Decreased joint motion causes disability by mechanisms including capsular contractures, muscle contractures, and muscle spasm[2].

The standardized regression coefficients of pain coping were in the same range as the kinesiological factors. Reducing demands, worrying, resting, and a low level of distraction were associated with greater disability. These associations occurred after controlling for all other characteristics. This suggests that, in addition to the pathway through muscle strength and range of motion, these psychological characteristics affect disability through other pathways. One possible pathway is aerobic fitness: avoidance of pain related activity may induce reduced aerobic fitness and thus disability[9,31]. Another pathway could be through the patient's self-efficacy beliefs: after sustained avoidance of pain related activity the patient with OA no longer believes in his or her capacity to perform certain activities, which causes disability[9]. Again, it should be noted that the present cross sectional study does not allow causal conclusions: longitudinal studies and studies on biobehavioral mechanisms of disability in patients with OA are required to establish causal relationships. In view of our results such studies are warranted.

The association of disability with pain coping and psychological well being is weaker than might be expected from most earlier research[32–34]. In one study[9], comparable

Table 4. Multiple regression analysis: observed and self-reported disability.

	Hip, n = 73		Knee, n = 112	
	Observed Disability	Self-reported Disability	Observed Disability	Self-reported Disability
Radiological status	—	—	—	—
Muscle strength	–0.27**	—	–0.24**	–0.22**
Range of motion	–0.23*	–0.19*	–0.27**	–0.28**
Pain	0.28**	0.22*	—	0.21*
Pain coping[a]				
Pain transformation	—	—	—	—
Distraction	–0.18*	—	—	—
Reducing demands	0.23**	—	—	—
Retreating	—	—	—	—
Worrying	—		0.20*	—
Resting	—	0.31**	0.21**	0.26**
Fear avoidance beliefs	—	—	—	—
Psychological well being[b]				
Anxiety	—	0.30**	—	—
Depression	—	—	—	—
Cheerfulness	—	—	—	—
Medication				
Paracetamol	—	—	—	—
NSAID	—	—	–0.16*	—
Others				
Age	0.29**	0.21*	0.19*	—
Sex	—	—	—	—
Duration of complaints[c]	—	—	—	—
Final R^2 adjusted	0.51**	0.48**	0.45**	0.40**

*p ≤ 0.05; **p ≤ 0.01.

[a]A high score reflects a high use of this strategy when in pain.

[b]A high score reflects that this aspect highly applies.

[c]Logarithmic transformation.

results were found. An important difference between our study and most earlier work is in the study population. Our sample consisted of patients applying for treatment in a GP practice, whereas other studies frequently used patient samples from hospitals or pain clinics. Our sample consisted of patients with relatively mild articular disease of relative short duration. The study population of Rejeski, *et al*[9] consisting of community based adults was comparable to ours. Patient samples from hospitals and pain clinics are more selective, possibly representing patients with a longer chronicity of complaints. It has been argued that with growing chronicity psychological factors gain importance in determining disability[35].

The attempt to explain pain was less successful. In the multivariate analyses, pain was significantly explained, but the amount of explained variance was smaller than in the case of disability. Decreased muscle strength was associated with pain only in hip patients. Resting as a coping strategy and fear avoidance beliefs were associated with pain in hip patients, and retreating was associated with pain in knee patients. In both hip and knee patients radiological status and range of joint motion were not associated with pain. In view of the small amount of explained variance it is clear that processes other than those investigated in our study also determine pain in patients with OA. Presumably, processes in the OA joint (e.g., secondary inflammation) should be scrutinized much more closely. It should be noted that our results point to a discrepancy between pain and disability: although the kinesiological and psychological characteristics were shown to be of considerable relevance with regard to disability, they seem to be less relevant with regard to pain. This confirms a much more tentative conclusion concerning a discrepancy between determinants of pain and determinants of disability in patients with OA.

The results with regard to observed and self-reported disability were only slightly different. Because of the possibility of common subjective factors, it was anticipated that self-reported disability would be associated rather closely with psychological characteristics, while observed disability would be more closely associated with "objectively" assessed kinesiological characteristics[9,36]. This explanation was not borne out. Thus, it seems that the determinants of observed and self-reported disability are largely identical. Of course, more and better focused research is required before a definite conclusion can be reached in this area.

The results with regard to hip patients and knee patients were rather similar, although some differences were observed. In hip patients, in contrast to knee patients, muscle strength was significantly associated with pain. Also, the duration of complaints was associated with pain in hip patients in contrast to knee patients. No clear differences were found concerning the associations with disability. The similarity of the results of hip patients and knee patients cannot be attributed to the inclusion in both categories of patients with a double diagnosis. Exclusion of these patients did not change our results. Because of the high degree of similarity, it seems that in hip OA patients and in knee OA patients disability is caused and maintained by largely the same set of factors.

Recently, knee OA has also been divided by pattern of localization into tibiofemoral OA and patellofemoral OA. It has been suggested that causes of these 2 patterns differ[37]. However, in a recent study this could not be confirmed[17]. Due to the small numbers of patients with a specific pattern, we could not study the relationships with pain and disability in these subgroups.

The clinical implications of our study are straightforward. First, the results suggest that improvement of muscle strength through exercise therapy results in reduction of both pain and disability. In addition, improvement of range of joint motion may result in a decrease of disability. Some research is available to evaluate these suggestions[31,38]. Second, improvement of coping strategies may contribute to a reduction of disability and possibly pain. Research on cognitive behavior therapy in patients with OA does support this suggestion[39]. However, additional controlled studies are needed to provide evidence for these suggestions.

We conclude that, after controlling for other characteristics, muscle strength, range of joint motion, and pain coping are each associated with disability in patients with OA of the hip or knee. Pain was associated with muscle strength and pain coping only. These results provide a reason for research on mechanisms underlying these associations.

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