Factors Associated With the Outcome of a First-Line Intervention for Patients With Hip or Knee Osteoarthritis or Both: Data From the BOA Register

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Objective. This study explored the association of patients' demographics, health status, symptom severity, previous osteoarthritis (OA) care, and psychological status with the change in pain severity following a first-line intervention including education and exercise for OA provided nationwide in Swedish primary care.

Methods. This register-based cohort study included 23,309 people with knee or hip OA from the Better Management of Patients with OA register. Linear regression models were used to assess the association of independent variables with the change in pain from baseline to 3 and 12 months. All the analyses were stratified based on the affected joint (hip vs knee).

Results. In people with hip and people with knee OA, high levels of baseline pain were associated with decreased pain at both follow-ups (3 months: knee B = −.67; hip B = −.64; 12 months: knee B = −.70; hip B = −.66), whereas being older, overweight, or female had a weak or no association. Finally, at both follow-ups, bilateral OA was associated with increased pain only in people with knee OA, whereas comorbidities and the willingness to undergo surgery were associated with increased pain regardless of the affected joint.

Conclusions. Baseline pain showed the strongest association among the analyzed variables, whereas sex, age, and body mass index appear to be weakly associated with the pain change after a first-line intervention. Comorbidities and willingness to undergo surgery showed a potentially important association and may have a negative impact on the pain change following a first-line intervention.

Impact. In people with hip or knee OA, age, sex, body mass index, and previous surgery are only weakly associated with the change in pain after a first-line intervention supporting the evidence recommending exercise and education as a foundation for all OA therapy. Having comorbidities and being willing to undergo surgery is associated with a worse outcome from a first-line intervention, including exercise and education. Individualized treatments addressing the disease perception and the specific comorbidity profile may improve the outcomes.

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Osteoarthritis (OA) is one of the main causes of activity limitations in older adults, which places it among the world's 10 most disabling conditions.[1] Roughly 40% of the world population aged older than 65 years is estimated to have OA, with an annual health care cost estimated to be as high as 7 billion euros in Europe only.[2,3] Without a cure for OA, the management of the disease focuses primarily on pain reduction and symptomatic relief. International guidelines recommend education and exercise as the first-line intervention for OA to reduce pain and improve patients' quality of life.[4,5]

Yet, results from education- and exercise-based interventions vary largely between individuals and joint affected (hip vs knee).[6,7] Treatments for OA tend to be one-size-fits-all, largely due to the lack of information regarding the effect that patients' specific characteristics have on treatment response. Indeed, OA is caused by a multitude of factors (eg, biomechanical, metabolic, genetic), which influence both the disease process and the individual's perception of pain.[8–11] In this context, OA is hypothesized to be a syndrome comprised of multiple phenotypes.[8,12] Identifying a relationship between patient- and disease-specific factors and treatment response represents a key step toward personalized OA care.

Information such as patients' demographics (age, sex, education), health status (physical activity, body mass index [BMI]), symptom severity (pain frequency, bilateral OA, walking difficulties), previous OA care (previous surgery, drug intake, previous rehabilitation), and psychological status (fear of movement, self-efficacy) is often collected in clinical practice and used by clinicians to design interventions. Previous evidence has shown that these factors have the potential to impact disease status and progression and may be important when planning interventions for people with OA.[10,13–16]

However, little is known about the association of these factors with the outcome of first-line interventions. Previous studies often examined single factors in isolation using samples originally recruited for randomized controlled trials, potentially missing key interactions and generating results that may not be transferrable to the general population seeking OA care.[17,18] Finally, people with knee and/or hip OA appear to respond differently to first-line interventions, with different factors potentially responsible for this difference.

This study aims to provide a comprehensive exploration of the joint-specific association of patients' demographics; health, disease, and psychological status; and previous OA care with the change in pain severity following a first-line intervention provided nation-wide in Swedish primary care.

Methods

Study Design

This is a register-based cohort study with sociodemographic, health status, disease severity, previous OA care, and psychological factors assessed at baseline and after 3 and 12 months following a first-line intervention. The study was approved by the Regional Ethical Review Board in Gothenburg (1059–16).

Intervention: Better Management of Patients With Osteoarthritis (BOA)

BOA is a national quality register including data from a first-line intervention provided nationwide in Sweden to people with OA of the knee, hip, hand, and shoulder. All the patients taking part in BOA receive a minimum of 2 theoretical group sessions led by a physical therapist focusing on the disease pathophysiology and on the benefit of exercise, including self-management advice and strategy to incorporate exercise into daily life.[19] Participants can then take part in a 1-on-1 session with a physical therapist who designs a rehabilitation program in accordance with OA clinical guidelines and based on the patient's specific needs and goals.[20] During this session, the participants are instructed on how to perform the program independently and how to manage the pain during the exercise using a tolerable pain model.[21] Finally, participants can decide to perform their exercise program at home or under the supervision of a physical therapist in 12 group sessions of the duration of 1 hour provided twice per week for a total of 6 weeks. Further details on the BOA program can be found elsewhere.[19]

Study Sample

The study sample consisted of people with knee and/or hip OA who participated in BOA between 2008 and December 2016. The presence of a clinical diagnosis of OA from primary or secondary care is the only criteria necessary to be eligible for BOA. The exclusion criteria are joint pain caused by another disease (eg, hip fractures, inflammatory joint disease, cancer), total joint replacement within the past 12 months; other surgery to the knee or hip within the past 3 months (eg, meniscectomy); or does not understand Swedish. The index joint was selected by the physical therapist based on the participant's medical history, symptoms, and results of the clinical examination. In the case of OA affecting multiple joints, the most symptomatic joint was considered as the index joint for the treatment. The patient-reported outcomes were assessed at the baseline and the 3-month follow-up during a visit with a physical therapist. During these visits, the physical therapist performed a clinical examination, delivered the questionnaires for the self-reported outcomes, and entered the data into the register. At the 12-month follow-up, the questionnaires for the self-reported outcomes were sent to the participants by mail with a prepaid envelope to return

the completed questionnaires. Patients who attended the two education sessions provided in BOA and either home or supervised exercise with data available at both follow-ups were included in this study. Participants followed-up later than the indicated period or with data missing at one of the follow-ups were excluded from the study.

Included Variables

Pain intensity. Mean pain intensity during the last week in the index joint was evaluated at baseline and follow-ups on a numeric rating scale (NRS) ranging from 0 (no pain) to 10 (maximum pain). The NRS is a valid, reliable, and responsive measure of pain widely used in people with OA.[22] The change in pain was used as the dependent variable and was calculated as the difference between follow-up pain and baseline pain.

Sociodemographics. Participants reported their age, sex, level of education (<14 years; ≥14 years), and living situation (living alone, living with someone).

Health-related factors. Participants rated their general health status on a visual analogue scale with a score ranging from 0 (poor health) to 100 (excellent health). Body weight and height were self-reported at the first visit from which the BMI was calculated as kg/m^2.

Pain frequency. Pain frequency was assessed by a question: "How often do you have pain in your knee/hip," with 5 possible answers: never, every month, every week, every day, or all the time. For the purpose of the study, we have dichotomized this question to frequent pain (every day or all the time) and infrequent pain (every week, every month, never).

Intake of drugs for OA. Intake of drugs was evaluated by the physiotherapist asking the patients whether they had taken any drugs for OA during the last 3 months because of their knee/hip pain. The question was dichotomized into "yes" or "no." Any kind of drug prescribed for OA or taken to subside the OA-related joint symptoms was considered for this variable.

Self-efficacy. Self-efficacy was assessed by the Arthritis Self-Efficacy Scale, which is designed to assess participants' confidence in their ability to manage symptoms of arthritis. The final score ranges from 10 to 100, with higher values representing higher self-efficacy. In BOA, only the scale assessing pain and other symptoms self-efficacy have been included. Arthritis Self-Efficacy Scale has previously been used to evaluate patient education programs for patients with arthritis and is validated in Swedish.[23,24]

Willingness to undergo surgery. The willingness to undergo surgery was assessed by the question "Are your knee/hip symptoms so severe that you wish to undergo surgery? (yes/no)."

Fear of movement. Fear of movement was assessed by the question "Are you afraid your joints will be injured by physical training/activity? (yes/no)."

Physical activity. Physical activity was assessed by the question "How active are you during a regular, typical week," with 7 possible answers: inactive, less than 30 minutes, 30 to 60 minutes, 60 to 90 minutes, 90 to 150 minutes, 150 to 300 minutes, and more than 300 minutes. The question was dichotomized into <150 min/wk and ≥150 min/wk based on the international recommendation for physical activity.[25]

Charnley classification. The Charnley classification categorizes patients into 3 classes: A, unilateral OA (knee or hip); B, bilateral OA (both knees or both hips); C, OA in multiple joint sites (eg, hip and knee) and the presence of any other disease that affects walking ability.[26,27]

Treatment modality. BOA participants received a personalized exercise program and could decide to carry it out (1) unsupervised at home or (2) supervised by a physical therapist in 12 group exercise sessions.

Statistical Analysis

All the analyses were stratified based on the index joint. Separate linear regression models were used to assess the association of the independent variables with the change in pain from baseline to 3 months, and from baseline to 12 months. Categorical variables were coded as dummy variables before being included in the model. Negative values indicate a reduction of pain. Assumptions for multiple linear regressions were checked and examination of multicollinearity between variables conducted. Initially, all the independent variables were entered simultaneously in the model. An augmented backward elimination process was adopted.[28] Variables with $\alpha \geq .2$ were excluded one-by-one from the model unless their exclusion led to a change in the estimates of the other factors >10%, in which case the variable was retained as a confounder together with variables with $\alpha > .05$ and <.2.[28,29] Alpha-level was set at .05, all the variables reaching statistical significance were retained in the models. All statistical analyses were conducted usin g SPSS software (v 25.0, SPSS, Chicago, IL). Results are presented as unstandardised regression coefficients (B) and are accompanied by 95% CI. A change of 1 point on the NRS scale at the follow-ups was considered clinically relevant. This cut-off was previously validated in a sample of people with OA and other chronic rheumatic conditions and indicates subjects feeling slightly better.[30]

Results

Among the people who took part in BOA, 44,228 had knee or hip OA and took part in the one-to-one session with a physical therapist receiving a personalized exercise program. Of these, 20,919 did not report data at one or

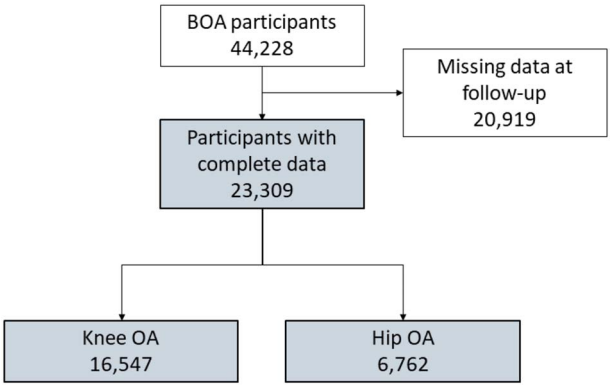

Figure.
Study flowchart

both follow-ups, were followed-up outside the established time frame, or were not yet followed-up at the time of the data extraction (Figure). Baseline characteristics of the subjects who were not included in the study are reported in Table 1. Excluded patients showed similar characteristics to the people included in the study despite a higher prevalence of people willing to undergo joint replacement.

A total of 23,309 people were included in this study. The mean change in pain was −1.27 (SD = 2.14) and −0.98 (SD = 2.34) at 3 months and −0.93 (SD = 2.10) and −0.47 (SD = 2.32) at 12 months for people with knee and/or hip OA, respectively.

Knee OA

Baseline pain, BMI, health-related quality of life, education, treatment group, pain frequency, Charnley class, previous surgery to the index knee, previous physical therapy, willingness to undergo surgery, fear of movement, and pain self-efficacy were associated with the change in pain at 3 months ($P < .001$, adjusted $R^2 = .28$) (Tab. 2). Age, previous contralateral surgery, and other symptoms self-efficacy did not reach statistical significance but were retained in the model as confounders.

Baseline pain, BMI, age, quality of life, education, pain frequency, Charnley class, walking difficulties, previous surgery to the index knee, previous physical therapy, willingness to undergo surgery, fear of movement, and pain self-efficacy were associated with the change in pain at 12 months ($P < .001$, adjusted $R^2 = .26$). Previous contralateral surgery and other symptoms self-efficacy were the only non-significant variables retained in this model as confounders.

Hip OA

Baseline pain, BMI, health-related quality of life, education, pain frequency, Charnley class C, willingness to undergo surgery, and pain self-efficacy pain were associated with the change in pain at 3 months ($P < .001$, adjusted $R^2 = .25$) (Tab. 2). Sex, Charnley class B, walking difficulties, and previous physical therapy were not statistically significant but were retained in the model as confounders.

Baseline pain, BMI, quality of life, physical activity, pain frequency, Charnley class C, walking difficulties, drugs for OA in the last 3 months, previous physical therapy, willingness to undergo surgery, and pain self-efficacy were associated with the change in pain at 12 months ($P < .001$, adjusted $R^2 = .23$) (Tab. 2). Sex, living situation, education, Charnley class A, and fear of movement were not significant but were retained in the model as confounders.

Discussions

To the best of our knowledge, this is the first study exploring the association between person- and disease-specific factors and the change in pain after 3 and 12 months in more than 20,000 people with knee and/or hip OA who underwent a first-line intervention.

Pain is the most disabling symptom for people with OA and one of the major drivers of clinical decision-making. In this study, higher levels of baseline pain were associated with a larger absolute reduction in pain intensity at both follow-ups, confirming previous evidence suggesting that exercise for knee and/or hip OA is effective regardless of the intensity of pain.[4] This can be partially explained through a regression to the mean effect. However, previous evidence from BOA data showed the superiority of exercise compared with a minimal intervention including only education, suggesting that the treatment plays a role in explaining the observed changes.[31] As opposed to pain intensity, frequent pain at baseline was associated with increased pain at both follow-ups, especially in people with knee OA. This can be explained by the fact that frequent pain is linked to worse symptomatic and structural disease severity, which may negatively impact the outcome of the intervention.[32]

Older age, female sex, and high BMI have been shown to be associated with more severe symptoms and faster disease progression.[33,34] In our study, only BMI was associated with an increase in pain after the treatment across all the follow-ups and regardless of the joint involved (hip or knee), but the association was of questionable clinical importance. The current results suggest that first-line interventions should be advised regardless of the person's age, sex, and BMI. However, addressing weight reduction in overweight or obese people with OA is key to improve health and maximize exercise benefits.[35]

Baseline physical activity had no effect on pain change after treatment with the exception of people with hip OA

Table 1.
Baseline Characteristics for Excluded and Included Patients[a]

Cohort and No. of Patients	Excluded (n = 20,919)	Knee OA (n = 16,547)		Hip OA (n = 6762)	
Baseline Characteristics	**Mean (SD) or %**	**Patients Reporting Outcome**	**Mean (SD) or %**	**Patients Reporting Outcome**	**Mean (SD) or %**
Baseline pain (0–10)	5.5 (1.95)	16,507	5.1 (1.95)	6745	5.1 (1.93)
Age (y)	65.7 (9.55)	16,547	66.3 (9.02)	6762	67.1 (9.14)
BMI	28.1 (4.85)	16,268	28.2 (4.93)	6657	26.7 (4.3)
Sex		16,547		6762	
Men	31.3	4929	29.8	21,985	29.4
Women	68.7	11,618	70.2	4777	70.6
Quality of life (0–100)	65.0 (19.63)	13,278	68.6 (18.46)	5560	67.1 (18.71)
Physical activity (min/wk)		13,331		5585	
<150	60.6	7420	55.7	3024	54.1
≥150	39.4	6064	44.3	2561	45.9
Living situation		16,495		6747	
With someone	71.6	12,122	73.5	4941	73.2
Alone	28.4	4373	26.5	1806	26.8
Education (y)		16,501		6741	
Low (0–13)	72.6	11,560	70.1	4666	69.2
High (≥14)	27.4	4941	29.9	2075	30.8
Treatment modality		16,441		6730	
Home exercise	41.2	6722	40.9	2813	41.8
Supervised exercise	58.8	9719	59.1	3917	58.2
Pain frequency		16,490		6730	
Every week or less often	15.5	3191	19.4	1237	18.4
Every day or all the time	84.5	13,299	80.6	5493	81.6
Charnley class		16,547		6733	
A (1 joint with OA)	38.2	6465	39.0	2540	38.0
B (bilateral OA)	17.8	3970	24.3	775	11.5
C (bilateral OA + other comorbidities)	44.0	6112	37.7	3418	50.5
Walking difficulties due to OA		16,466		6725	
No	16.4	3530	21.4	1467	21.8
Yes	82.7	12,936	78.6	65,258	78.2
Drugs for OA in last 3 mo		16,496		6,733	
No	22.7	4238	25.7	1740	25.8
Yes	76.8	12,258	74.1	4993	74.2
Previous surgery index joint		16,520		6748	

(Continued)

Table 1.
Continued

Cohort and No. of Patients	Excluded (n = 20,919)	Knee OA (n = 16,547)		Hip OA (n = 6762)	
Baseline Characteristics	**Mean (SD) or %**	**Patients Reporting Outcome**	**Mean (SD) or %**	**Patients Reporting Outcome**	**Mean (SD) or %**
No	87.0	13,704	83.0	6627	98.2
Yes	13.0	2816	17.0	121	1.8
Previous surgery contralateral		16,472		6737	
No	87.2	14,642	88.9	6284	93.3
Yes	11.3	1830	11.1	453	6.7
Previous physical therapy		16,498		6740	
No	54.4	8829	53.5	3660	54.3
Yes	45.6	7669	46.5	3080	45.7
Willingness to undergo surgery		16,495		6705	
No	69.5	13,158	80.3	5334	79.6
Yes	30.5	3237	19.7	1371	20.4
Fear of movement		16,459		6728	
No	82.6	13,738	83.5	5823	86.5
Yes	17.4	2271	16.5	905	13.5
ASES pain (0–100)	61.2 (19.24)	16,167	65.2 (18.26)	6602	62.5 (18.34)
ASES symptoms (0–100)	66.1 (17.41)	16,064	69.0 (16.44)	6556	67.7 (16.4)

[a]ASES = Arthritis Self-Efficacy Scale; BMI = body mass index; OA = osteoarthritis.

at 12 months, where the effect is of scarce clinical importance. This result confirms previous findings from similar first-line interventions suggesting that people with OA may benefit from education and exercise regardless of their initial level of physical activity.[14]

In this study, higher levels of pain self-efficacy and quality of life were associated with lower levels of pain at both follow-ups, confirming results from previous studies. People with high self-efficacy tend to report less pain and higher quality of life and are more willing to pursue challenges, which may explain these results.[15,36] Despite this, the association of baseline pain self-efficacy on the change in pain was somewhat weak. Similarly, quality of life had a small association with the change of pain, which could hardly be clinically significant when considered in isolation.

Having OA in multiple joints and comorbidities is associated with worse symptoms and physical function.[16,37] In the current study, bilateral OA (Charnley class B) was associated with an increase in pain in people with knee OA at both follow-ups. The addition of other comorbidities influencing the gait (Charnley class C) led to increased pain in both joint subgroups, with a potentially clinically important association in people with knee OA, especially at 12 months. These results underline the potential importance of adapting first-line interventions to the patient's comorbidity profile, which may maximize treatment benefits.[38] More information regarding the severity of the symptoms in the contralateral joint and the number and severity of comorbidities may help clarify the difference in the association between people with knee and/or hip OA.

Previous care for OA had a somewhat contrasting association with the outcome under examination. Taking OA-related drugs in the 3 months preceding the intervention was not associated with the change in pain following the intervention (3 months). However, in people with hip OA, taking drugs for OA was associated with a small pain increase at 12 months (B: 95% CI = 0.05 to 0.27). This result is hard to interpret due to the lack of information in the BOA register regarding the type of drug, dose, and treatment plan. However, taking drugs before the intervention does not seem to be associated

Table 2.
Regression Coefficients of Factors Associated With Pain Reduction at 3 and 12 Months After Intervention[a]

Baseline Characteristics	Knee OA[b]		Hip OA[b]	
	3 Months B (95% CI)	12 Months B (95% CI)	3 Months B (95% CI)	12 Months B (95% CI)
Baseline pain (0–10)	**−0.67 (−0.69 to − 0.65)**	**−0.70 (−0.72 to − 0.67)**	**−0.64 (−0.67 to 0.66)**	**−0.66 (−0.70 to − 0.63)**
Age (y)	0.00 (0.00 to 0.01)	**0.01 (0.01 to 0.02)**	n/a	n/a
BMI	**0.02 (0.02 to 0.03)**	**0.03 (0.02 to 0.04)**	**0.02 (0.01 to 0.03)**	**0.04 (0.03 to 0.06)**
Sex				
Men	Reference	Reference	Reference	Reference
Women	n/a	n/a	0.078 (−0.23 to 0.18)	n/a
Quality of life (0–100)	**−0.01 (−0.01 to − 0.01)**	**−0.01 (−0.01 to − 0.01)**	**−0.01 (−0.01 to − 0.00)**	**−0.01 (−0.01 to − 0.00)**
Physical activity (min/wk)				
<150	Reference	Reference	Reference	Reference
≥150	n/a	n/a	n/a	**−0.15 (−0.26 to − 0.04)**
Living situation				
Live with someone	Reference	Reference	Reference	Reference
Live alone	n/a	n/a	n/a	0.12 (−0.00 to 0.24)
Education (y)				
Low (0–14)	Reference	Reference	Reference	Reference
High (>14)	**−0.12 (−0.19 to − 0.05)**	**−0.24 (−0.32 to − 0.16)**	**−0.13 (−0.23 to − 0.02)**	−0.16 (−0.28 to −0.38)
Pain frequency				
Every week or less often	Reference	Reference	Reference	Reference
Every day or all the time	**0.36 (0.27 to 0.45)**	**0.35 (0.26 to 0.44)**	**0.28 (0.14 to 0.41)**	**0.34 (0.19 to 0.50)**
Charnley class				
A (1 joint with OA)	Reference	Reference	Reference	Reference
B (bilateral OA)	**0.38 (0.30 to 0.46)**	**0.50 (0.34 to 0.67)**	0.13 (−0.03 to 0.29)	0.10 (−0.84 to 0.28)
C (bilateral OA + other comorbidities)	**0.49 (0.41 to 0.56)**	**0.71 (0.56 to 0.86)**	**0.22 (0.11 to 0.33)**	**0.32 (0.20 to 0.44)**
Walking difficulties due to OA				
No	Reference	Reference	Reference	Reference
Yes	n/a	**0.20 (0.11 to 0.29)**	0.16 (0.03 to 0.29)	**0.38 (0.24 to 0.52)**
Drugs for OA in last 3 mo				
No	Reference	Reference	Reference	Reference
Yes	n/a	n/a	n/a	**0.16 (0.04 to 0.28)**
Previous surgery				
No	Reference	Reference	Reference	Reference
Yes	**0.12 (0.03 to 0.20)**	**0.33 (0.23 to 0.42)**	n/a	n/a
Previous surgery contralateral				
No	Reference	Reference	Reference	Reference
Yes	0.07 (−0.29 to 0.18)	0.07 (−0.02 to 0.19)	n/a	n/a
Previous physical therapy				
No	Reference	Reference	Reference	Reference
Yes	**0.15 (0.08 to 0.21)**	**0.16 (0.09 to 0.23)**	0.09 (−0.011 to 0.186)	**0.16 (0.05 to 0.27)**

(Continued)

Table 2.
Continued

Baseline Characteristics	Knee OA[b]		Hip OA[b]	
	3 Months B (95% CI)	12 Months B (95% CI)	3 Months B (95% CI)	12 Months B (95% CI)
Willingness to undergo surgery				
No	Reference	Reference	Reference	Reference
Yes	**0.36 (0.28 to 0.45)**	**0.51 (0.42 to 0.61)**	**0.50 (0.363 to 0.632)**	**0.50 (0.35 to 0.65)**
Fear of movement				
No	Reference	Reference	Reference	Reference
Yes	**−0.10 (−0.01 to − 0.03)**	**−0.23 (−0.33 to − 0.13)**	n/a	−0.15 (−0.31 to 0.01)
ASES pain (0–100)	**−0.01 (−0.01 to − 0.01)**	**−0.01 (−0.01 to − 0.01)**	**−0.01 (−0.013 to − 0.007)**	**−0.01 (−0.01 to − 0.01)**
ASES symptoms (0–100)	−0.00 (−0.01 to 0.00)	−0.00 (−0.01 to 0.00)	n/a	n/a

[a]ASES = Arthritis Self-Efficacy Scale; B = unstandardized regression coefficient; BMI = body mass index; n/a = not available due to being dropped during the backward elimination process; OA = osteoarthritis.
[b]Statistically significant results are reported in bold.

with additional benefit, reinforcing the idea that exercise and education should be proposed before attempting other treatments.

Having received previous physical therapy was associated with increased pain in both joint sub-groups at both follow-ups. Due to the lack of information regarding the number and content of rehabilitation sessions undertaken, interpretation of these results requires care. It is possible that having sought care from a physical therapist may be a proxy for disease severity, explaining the increase in pain. It can also be hypothesized that people who received rehabilitation may have already implemented changes in their daily life that are suggested in BOA, thus reducing the benefit of the intervention.

The presence of walking difficulties was the only available measure to capture disability in the cohort and was associated in both the joint subgroups with increased pain at 12 months only. More objective measures of disability are needed to clarify the association between physical impairments and pain reduction after first-line interventions.

Having received previous surgery (eg, anterior cruciate ligament reconstruction, meniscectomy) had a potentially important association with increased pain only in people with knee OA, particularly at 12 months. These results suggest that for those with knee OA who underwent surgery, first-line intervention may be effective in the short term, while longer interventions (>12 sessions) may be necessary to prolong the benefits. The absence of an association between previous surgery and pain reduction in people with hip OA may be due to the small number of people with hip OA who received surgery before enrolment in BOA (hip OA = 1.8%; knee OA = 17%).

Willingness to undergo surgery at baseline was associated with a potentially important increase in pain at both follow-ups, regardless of the affected joint. More severe symptoms and disability, as well as previous experiences and expectations, are linked to the desire for surgery and have the potential to influence the outcome of treatments.[39,40] This suggests that willingness to undergo surgery may be a proxy for disease severity and other factors potentially explaining some of the variation not fully captured by the included variables. Previous evidence has shown that exercise and education are effective in patients listed for surgery and can delay surgery for at least 2 years.[41-43] However, willingness to undergo surgery appears to be linked to a worse outcome, and it should be taken into consideration when designing and delivering first-line interventions.

Preliminary evidence suggests that people with knee OA experience greater improvements after undergoing first-line interventions compared with people with hip OA.[6,7,31] Despite several hypotheses based on differences in joint biomechanics and disease mechanisms, the reason for the different response to first-line interventions is still not clear. This study showed a similar pattern in the association between the examined variables and the change in pain after the intervention in people with knee and hip OA. Among the variables that show a different association, most are of scarce clinical importance due to the small magnitude of the association (ie, physical activity, previous drugs for OA, fear of movement), and they could hardly explain the difference in treatment outcomes. Of potential clinical importance, bilateral OA and additional comorbidity showed an association with increased pain only in people with knee OA. Similarly, fear of movement in people with knee OA, but not in those with hip OA, seem to be associated with greater

pain reduction following the intervention. Considering that the knee joint is more biomechanically unstable than the hip, it can be hypothesized that the improvement of neuromuscular control that follows exercise may lead to greater benefits in people with knee OA and fear of movement. However, further research is needed to clarify the reason for these differences.

Overall, among the variables analyzed, only having Charnley class C, walking difficulties, and having received previous surgery showed different levels of association (without overlapping CI) between 3 and 12 months. People presenting these characteristics may be thought to have a more severe disease, which, in turn, can explain the larger pain increase showed at 12 months after the treatment was terminated. The different associations between follow-ups may suggest that longer intervention may be needed to mitigate the increase in pain in the year following the intervention, possibly mitigating the pain increase observed in the long term. The other analyzed variables showed, instead, similar associations between the follow-ups, suggesting that these variables have a similar influence on the pain change regardless of the follow-up time.

Finally, baseline pain appeared to be the factor more strongly associated with the change in pain after a first-line intervention followed by the presence of comorbidity (Charnley class), willingness to undergo surgery, and baseline pain frequency. These results seem to suggest that factors linked to disease severity are more strongly associated with absolute pain reduction than other factors such as age and BMI. However, while higher pain is associated with greater pain reduction, the presence of walking disability or comorbidities appear to be associated with worse pain following a first-line intervention. However, little can be said regarding the role of the analyzed variable in the mechanisms leading to the pain reduction. Further research building on these results and exploring the causal pathways is warranted to disentangle the relationship between these variables and the pain reduction.

This study has some limitations that need to be discussed. First of all, the observational nature of the study does not allow us to establish causality and to draw any conclusion on the effect of the treatment on the pain change. A large number of variables were not reported at baseline, most likely due to a missed upload to BOA by the physical therapist responsible for uploading the data at the local unit. For this reason, we assumed that missing data at baseline may be considered to be missing at random and should introduce no or minimal bias in the analysis. However, it was not possible to verify the real reason for the data missing data. Thus, we recommend interpreting the results cautiously, taking into account possible biases due to missing data. Pain was the only outcome tested for association with baseline variables. This implies that examined variables may have important associations with other key therapeutically outcomes like physical function, which is not available in the register. Including additional variables may increase the low variance explained by the models. Despite being hard to capture, contextual factors including patient-physical therapist relation, expectations, and personal preferences have an important role in determining treatment outcomes and may account for part of the unexplained variance.[44] Finally, none of the variables analyzed affected the change in pain that approached a 1-unit change, which is often considered to be the minimal clinically important difference for pain when measured on an NRS scale[30]; however, certain characteristics may tend to cluster together, potentially leading to clinically significant effects. For this reason, future research carefully exploring characteristics of responders to first-line management interventions is warranted. Despite these limitations, this study used data from more than 20,000 patients who received treatment in clinical practice nationwide, strengthening the clinical relevance and external validity of the results.

Conclusions

Providing the right treatment to the right patient is a key step in reducing the burden of OA for society and the patients. In this study, we showed that higher baseline pain was associated with greater (absolute) pain reduction and that participants' age, sex, BMI, and previous surgery are only weakly associated with the change in pain after a first-line intervention, somewhat supporting the evidence recommending exercise and education as a foundation for all OA therapy. Comorbidities and willingness to undergo surgery instead appear to be associated with a worse outcome from a first-line intervention and may require individualized treatments.

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Ethics Approval

This study was approved by the Regional Ethical Review Board in Gothenburg (1059–16).

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The authors completed the ICMJE Form for Disclosure of Potential Conflicts of Interest and reported no conflicts of interest. T. Jönsson is a member of the steering committee of the BOA register, for which she does not receive any financial compensation. L. Dahlberg is cofounder and chief medical officer of Joint Academy, a company that provides digital nonsurgical treatment for patients with hip and/or knee OA. L. Dahlberg owns stocks in, is a board member of, and is a paid part-time consultant for Joint Academy since May 1, 2019. H. Nero is a part-time employee at Joint Academy. Of note, Joint Academy has not supported this work financially and has thus played no role concerning study conception, study design, analysis of data, and manuscript compilation. All other authors report no competing interests.

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