Use of recommended non-surgical knee osteoarthritis management in patients prior to total knee arthroplasty: a cross-sectional study

Lauren K. King MBBS MSc[1], Deborah A. Marshall PhD[2], Peter Faris PhD[2], Linda Woodhouse PT PhD[3], C. Allyson Jones PhD[3], Tom Noseworthy MD MPH[2], Eric Bohm MD MSc[4], Michael Dunbar MD PhD[5], and Gillian A. Hawker MD MSc[1], on behalf of the BEST-Knee Team

Indexing Terms: Arthroplasty, Replacement, Knee; Osteoarthritis, Knee; Disease management; Professional Practice Gaps

[1] Department of Medicine, University of Toronto, Toronto, ON Canada

[2] Department of Community Health Sciences, University of Calgary, Calgary, AB, Canada

[3] Department of Physical Therapy, University of Alberta, Edmonton, AB, Canada

[4] Concordia Hip & Knee Institute, University of Manitoba, Winnipeg, MB, Canada

[5] Division of Orthopaedics, Department of Surgery, Dalhousie University and QEII Health Sciences Centre, Nova Scotia Health Authority, Halifax, NS, Canada

Conflicts of Interest:

Gillian Hawker has received research support as the Sir John and Lady Eaton Professor and Chair of Medicine, Department of Medicine, University of Toronto. Deborah Marshall is supported through a Canada Research Chair in Health Systems and Services Research and the

Arthur J.E. Child Chair in Rheumatology. All other authors declare no conflicts of interest related to the work under consideration for publication.

Correspondence To:

Dr. Gillian A. Hawker

Sir John and Lady Eaton Professor and Chair, Department of Medicine, University of Toronto

190 Elizabeth Street, Suite RFE 3-805, Toronto, Ontario, Canada M5G 2C4

Telephone: 416-946-8071; FAX: 416-978-7230; E-mail: g.hawker@utoronto.ca

Funding Statement:

This study was funded by an operating grant from the Canadian Institutes of Health Research, grant # MOP-312807.

ABSTRACT

OBJECTIVE: Our aim was to assess prior use of core recommended non-surgical treatment among patients with knee osteoarthritis (OA) scheduled for total knee arthroplasty (TKA); and, to assess potential patient-level correlates of underuse, if found.

METHODS: This was a cross-sectional study of patients undergoing TKA for primary knee OA at two provincial central intake hip and knee clinics in Alberta, Canada. Standardized questionnaires assessed socio-demographic characteristics, social support, coexisting medical conditions, OA symptoms and coping, and previous non-surgical management. Multivariable logistic regression was used to assess the patient-level variables independently associated with receipt of recommended non-surgical knee OA treatment, defined as prior use of pharmacotherapy for pain, rehabilitation strategies (exercise or physiotherapy), and weight loss if overweight or obese (body mass index ≥25 kg/m^2).

RESULTS: 1,273 patients were included: mean age 66.9 years [SD 8.7]; 39.9% male; 44.1% had less than post-secondary education. Recommended non-surgical knee OA treatment had been used by 59.7% of patients. In multivariable modeling, the odds of having received recommended non-surgical knee OA treatment was significantly and independently lower among individuals who were older (OR 0.96 [95%CI 0.95–0.98]), male (OR 0.41 [0.31–0.53]), and who lacked post-secondary education (OR 0.67 [0.52–0.87]).

CONCLUSION: In a large cross-sectional analysis of knee OA patients scheduled for TKA, 40% of individuals reported having not received core recommended non-surgical treatments. Older individuals, men and those with less education had lower odds of having used recommended non-surgical OA treatments.

INTRODUCTION

Total knee arthroplasty (TKA) for the treatment of advanced knee osteoarthritis (OA) is one of the most common and fastest growing surgical procedures in developed countries (1-3). In 2016-2017, over 67,000 TKAs were performed in Canada (4), with a utilization rate that is projected to continue to increase (5). While, on average, TKA is highly effective, 15-30% of recipients report little or no symptom improvement and/or dissatisfaction with results (6, 7). Thus, there is consensus that effective non-surgical options should be maximized before referral to surgery is considered (8-13).

Despite national and international evidence-based guidelines (14-18) for the non-surgical treatment of knee OA, underuse of effective therapies has been documented across multiple treatment settings (19-22). Barriers to receipt of knee OA treatment include lack of awareness of treatment availability or effectiveness, financial constraints and other difficulties accessing care, and presence of coexisting medical conditions that are prioritized or might contraindicate some therapies (23-25).

Two small studies have examined the prior use of non-pharmacological and pharmacological therapies in patients with knee OA receiving TKA. A UK study of 105 patients undergoing hip or knee arthroplasty found that 72% had used systemic analgesics, but only 49% had tried physiotherapy (PT) (26). A Dutch study of 195 patients found similar use of systemic analgesics, higher use of PT (73%), and that 30% of obese patients had tried a weight management strategy (27). These findings suggest a gap in care that, if addressed, has potential to reduce or

delay need for TKA for patients with knee OA. For example, Skou *et al.* showed that two-thirds of patients scheduled for TKA who received a 12-week comprehensive non-surgical treatment program elected to delay their surgery for at least two years (28).

The objectives of this study were to determine: 1) the proportion of patients undergoing TKA for primary knee OA who had received core recommended non-surgical treatments, defined as prior use of a recommended pharmacotherapy for pain, exercise or PT, and weight loss if overweight or obese; and 2) potential patient-level correlates of underuse, if found. Guided by the Andersen healthcare utilization model (29) (Figure 1), we hypothesized that prior use of non-surgical knee OA treatments would be related to predisposing factors (e.g., education and income, due to lower health literacy and inability to pay out-of-pocket costs for some treatments), enabling factors (e.g., social support, given the importance of peer support on uptake of and adherence to physical activity, and coexisting medical conditions, which may act as competing clinical demands and contraindications to some OA medications), and perceived need factors of patients (e.g., pain and disability, which may increase perceived need for treatment).

MATERIALS AND METHODS

Setting and Design

This was a cross-sectional study nested within a prospective cohort study. Participants were recruited consecutively between October 27, 2014 and September 30, 2016 at two provincial central intake orthopaedic hip and knee clinics in Calgary and Edmonton, Alberta, Canada.

These sites annually perform approximately 60% of the TKAs in the province. All surgeons (n=45) who perform TKA surgery at these centres were invited, agreed and provided written consent to participate in the study.

Participants

Inclusion criteria were: a diagnosis of primary knee OA, age 30 years or older, able to read and comprehend English, and consultation with an orthopedic surgeon regarding elective primary unilateral TKA. Eligible patients who were recommended for and consented to undergo TKA were included. We excluded participants who had missing data for the primary outcome.

Assessments

After providing written consent, participants self-completed a standardized computer-based questionnaire prior to consultation with the orthopaedic surgeon. The questionnaire assessed the following variables: Predisposing factors: Participants were asked to report their annual household income (<$60,000 vs. ≥$60,000), level of education (<post-secondary vs. post-secondary) and employment status (working for pay vs. other); Enabling factors: Social support was measured with the six-item Lubben social network scale (30), scored from 0 to 30, where higher scores indicate more support. Participants were also asked to self-report (yes/no) presence of the following chronic conditions, which may contraindicate use of some recommended OA therapies: heart disease, hypertension, lung disease, diabetes, ulcer or stomach disease, kidney disease, and liver disease. The eight-item Patient Health Questionnaire Depression Scale (PHQ-8) (31), scored from 0 to 24, where higher indicate more depressive

symptoms, was used to assess depressive symptoms, which may impact treatment uptake and adherence. Need factors: Self-reported knee OA symptoms were assessed using the five-item Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) pain subscale (32, 33), scored from 0 to 20 (higher scores indicate worse pain), and the seven-item Knee injury and Osteoarthritis Outcome Score physical function short form (KOOS-PS) (34), scored 0 to 100 (higher scores indicate worse disability (34)). Perceived ability to cope with different aspects of having knee OA was assessed using the four-item arthritis coping efficacy scale (35, 36), scored 4-20 (higher indicating greater coping efficacy).

To assess prior use of non-surgical knee OA treatments, patients were asked to indicate which of the following therapies for knee OA they had "ever tried" (yes/no): exercise ("exercise on your own or formal exercise program"), weight loss through any means ("weight loss"), physiotherapy (PT) ("assessment by a physiotherapist"); joint injections ("joint injections to your knee [i.e. cortisone, hyaluronic acid]"), acetaminophen ("acetaminophen [Tylenol (regular or extra strength) or Tylenol Arthritis]"), oral or topical NSAIDs ("anti-inflammatory drugs [by mouth or topically] i.e. Advil, naproxen, Voltaren, Arthrotec, ibuprofen, Celebrex") and opioid analgesics ("Painkillers with codeine [e.g. Tylenol #1,2,3; Percocet, oxycodone, MS Contin]"). Participants' age, sex, and height and weight, to calculate body mass index (BMI), were obtained from clinic records.

Outcomes

The primary outcome was a composite measure of prior use of recommended non-surgical OA treatment (yes/no), defined as having indicated "yes" to having tried exercise or PT *and* weight loss if overweight or obese (BMI ≥25 kg/m^2) *and at least one of* acetaminophen, oral or topical NSAIDs, or joint injection. This reflects the core recommended non-surgical knee OA treatments across multiple national and international guidelines (14-18), and is in keeping with published quality standards for the expected knee OA treatments that should be used before referral for consideration of joint surgery (13).

Secondary outcomes were: prior use of recommended non-pharmacological treatments (exercise or PT *and* weight loss if overweight or obese (yes/no), which was of interest as non-pharmacological OA treatments have been reported to be the most underused; and prior use of NSAIDs (yes/no), which we hypothesized might be underutilized in individuals with specific medical comorbidities.

Statistical Analyses

Distributions of all continuous variables were assessed for normality. Participant characteristics were summarized using frequencies, means and standard deviations (SD) or medians and interquartile ranges (IQR), as appropriate, overall and for those who had and had not received non-surgical OA treatment. Characteristics were compared using the chi-square test, t test, or Wilcoxon rank sum test, as appropriate.

For each outcome of interest, logistic regression was used to examine the relationship of the outcome with age, sex, level of education (post-secondary vs less), social support (Lubben score), knee symptom severity (WOMAC pain, KOOS function), and comorbid conditions. In the primary models, we examined the effects of specific comorbidities that may contraindicate use of NSAIDs (heart disease, hypertension, diabetes, kidney disease, and gastrointestinal disease) in addition to depressive symptoms (PHQ-8) and BMI. In a secondary analysis, these specific conditions were replaced with the number of comorbid conditions to assess the impact of overall burden of comorbidity. Because self-report of trying to lose weight may reflect variable practices, we conducted a sensitivity analysis removing the requirement of weight loss from our primary outcome. We used a forced entry multivariable model. We assessed for multicollinearity of covariates using Spearman and tetrachoric correlation coefficients and confirmed none were correlated at a rho of 0.6 or greater. With the exception of annual household income, where 11% of the data were missing, the level of missing-ness for all other variables of interest was very low (<2%); thus, imputation for missing data was not performed.

All statistical analyses were performed using SAS Studio version 3.71 (SAS Institute Inc., Cary, NC). We presented all estimates of association with 95% confidence intervals. Statistical significance was considered met at a two-sided p value of 0.05 in logistic regression analyses. For descriptive analyses, given multiple comparisons, we used a cut-off of 0.01.

Ethics Approval

The study was approved by the Research Ethics Boards of the Universities of Alberta (PRO-00051108) and Calgary (REB 14-1294), and from Women's College Hospital (REB 2014-0092) at the University of Toronto.

RESULTS

Participants Characteristics (Table 1)

Of 2,277 eligible knee OA patients assessed for TKA, 1,373 were recommend for and consented to undergo the procedure. Of these, 1,273 individuals (92.7%) with complete data for our primary outcome were included in our analyses. Their mean age was 66.9 years (SD 8.7), 39.9% were male, 44.1% did not have a post-secondary education and 54.3% had an annual household income less than $60,000. (**Table 1)** Mean BMI was 33 kg/m^2 (SD 6.3); 92.2% were overweight or obese. 78% had at least one of the conditions of interest (heart disease 15%, hypertension 53%, diabetes 17%, kidney disease 3% and gastrointestinal disease 12%). Median PHQ-8 score was 5.0/24 (IQR 2, 10) and mean score for arthritis coping efficacy was 13.2/20 (SD 3.9). Mean WOMAC pain score was 11.6 (SD 3.5) and mean KOOS-PS score was 53.6 (SD 17.3). Prior use of recommended non-surgical treatments, as we defined it, was associated with younger age, female sex, receipt of post-secondary education, and less depression ($p<0.01$) **(Table 1)**.

Prior Use of Non-Surgical OA Treatments

Among participants scheduled for TKA, most reported having used pharmacologic treatments; 75.4% had used acetaminophen, 76.0% had used NSAIDs, and 75.1% had received at least one knee injection. Fewer reported having used recommended non-pharmacological treatments:

75.2% had used exercise, 44.3% had received PT, and 69.2% of those who were overweight or obese had tried weight loss **(Table 1)**.

Results of Logistic Regression Modeling:

Primary Outcome: Recommended non-surgical treatment for knee OA (non-pharmacological and pharmacological treatment)

Over half the participants (59.7%) met our criteria for having received core recommended non-surgical knee OA treatment. In univariate analyses, the odds of reporting having ever used recommended non-surgical treatment, as defined, was significantly *lower* among individuals who were older, male, and had less education and significantly *higher* among individuals with symptoms of depression and greater knee pain and disability ($p<0.05$ for all) (Table 2). In multivariable analysis, the odds of prior use of recommended non-surgical knee OA treatment remained significantly and independently *lower* among individuals who were older (odds ratio [OR] per year 0.97, 95% confidence interval [CI] 0.95 to 0.99); OR per 10 years 0.74, 95% CI 0.62 to 0.89), male (OR 0.33, 95% CI 0.25 to 0.45), and with less education (OR for less than post-secondary education 0.70, 95% CI 0.53 to 0.93) and significantly *higher* in those with depressive symptoms (OR per unit increase PHQ-8 1.06, 95% CI 1.03 to 1.09). Prior use of recommended non-surgical knee OA treatment was also significantly *higher* in individuals with greater social support (OR per unit increase on Lubben 1.03, 95% CI 1.00 to 1.06) and in those with gastrointestinal (OR 1.64, 95% CI 1.04 to 2.58) and cardiovascular disease (OR 1.64, 95% CI 1.09 to 2.48) **(Table 2)**. The final model had good fit (Hosmer-Lemeshow goodness of fit p=0.82; c-

statistic = 0.70). A sensitivity analysis, removing the weight loss from our primary outcome, gave similar results (data not shown).

In secondary analyses, when specific comorbid conditions were replaced in the model by the number of coexisting conditions, we found no significant relationship between number of conditions and our outcome of interest (1 comorbidity vs. none OR 1.03, 95% CI 0.72 to 1.45; 2 comorbidities vs. none OR 1.27, 95% CI 0.86 to 1.85, 3 comorbidities vs. none OR 1.35, 95% CI 0.91 to 1.99).

Secondary Outcomes:

Non-Pharmacological Treatment (Exercise and/or PT *and* weight loss if overweight/obese)

61.6% of participants met our criteria for having used recommended non-pharmacological OA therapies, as defined. In multivariable analysis, the odds of reporting prior use of recommended non-pharmacological OA treatment was significantly and independently *lower* in individuals who were older (OR per year 0.98, 95% CI 0.96 to 1.00), male (OR 0.38, 95% CI 0.28 to 0.50), with less education (OR for high school education or less 0.66, 95% CI 0.50 to 0.88) and lower income (OR for income <$60,000 0.71, 95% CI 0.52 to 0.96) and *higher* in those with depressive symptoms (OR per unit increase PHQ-8 1.06, 95% CI 1.03 to 1.09), greater social support (OR per unit increase on Lubben 1.03, 95% CI 1.01 to 1.06), with gastrointestinal disease (OR 1.79, 95% CI 1.13 to 2.85) and with cardiovascular disease (OR 1.70, 95% 1.12 to 2.57) **(Table 3).**

Non-Steroidal Anti-Inflammatory Drugs (NSAIDs)

In multivariable analysis, the odds of reporting having ever used NSAIDs was significantly and independently *lower* among individuals who were older (OR per year increase 0.97, 95% CI

0.94-0.99) and male (OR 0.68, 95% CI 0.48 to 0.94). NSAID use was also lower among individuals with cardiovascular disease, kidney disease and diabetes but these effects did not reach statistical significance **(Table 4)**.

DISCUSSION

In a large cohort of patients with knee OA scheduled to undergo TKA, only 60% had previously received core recommended non-pharmacological and pharmacologic therapies for knee OA. Non-pharmacologic treatments, including exercise, PT and weight management, were disproportionally underused; while 97% had received pharmacological therapies for pain, only 62% had received non-pharmacological therapies. Given that orthopedic surgeons have indicated that having "an adequate trial of nonsurgical arthritis treatment" is an important criterion in assessing patient appropriateness for TKA (10), these findings indicate a concerning care gap. More appropriate use of evidence-based non-surgical care has potential to improve the pain, physical function and quality of life for patients with knee OA and may reduce or delay the need for TKA (28).

From the literature, major barriers to effective knee OA care include societal beliefs of patients and physicians about OA as a normal part of aging for which nothing can be done and the high prevalence of comorbid conditions, like diabetes and heart disease, that present competing demands and/or contraindicate the use of some OA therapies, e.g., NSAIDs (37, 38). Consistent with this, participants with heart disease and gastrointestinal disease had higher odds of receipt of recommended OA treatment, and particularly non-pharmacological therapies, but lower

odds of having received NSAIDs. These findings suggest that non-pharmacological treatments are sought preferentially when the risks of pharmacological therapy are increased. We also found higher odds of use of non-pharmacological care in individuals with more depressive symptoms. A potential explanation for this finding is that these individuals are experiencing greater OA pain and seeking relief from their health care providers.

Individuals with low income may be less likely to have used treatments that incur out-of-pocket costs. In Alberta, Canada, outpatient NSAIDs and knee injection medications are not publicly funded and funding for PT is limited. Consistent with the findings of others (39), individuals with lower income were less likely to have received PT or exercise. Given the effectiveness of therapeutic exercise in the management of knee OA (40), enhanced public funding for rehabilitation programs may be warranted. Lower education was also associated with lower odds of prior use of recommended treatments. Lower health literacy has been shown to negatively impact the uptake of treatments or health services (41, 42). Both patient income and education need to be considered in future implementation strategies.

Although the effect was modest, participants with more social support had higher odds of having used non-pharmacological therapies for their knee OA. This is consistent with the fact that these therapies require active patient engagement. Social support has been shown to be important in patient adherence to medical treatment (43) and should be harnessed in efforts to improve quality of OA care. Further research is warranted to examine the role of social support in improving knee OA care.

Male sex was strongly associated with lower odds of use of all OA treatments. Reasons for this are unclear although consistent with prior research on gender differences in health care utilization (44, 45). Compared with men, women with knee OA seek and receive TKA later in the course of their disease (46). Thus, a potential explanation is simply that women accrue a longer duration of time to have used treatments than their male counterparts.

Strengths of the study include the large sample size (patients and surgeons) and the breadth of patient characteristics assessed, which enhances generalizability, albeit within one health care system. A total of 45 surgeons practice in the two orthopedic centers from which we recruited participants; these surgeons collectively perform 60% of the TKAs in the province (>6,000/year). Thus, our results are likely to reflect a breadth of orthopaedic practices. However, there are also some important limitations. First, prior treatment was self-reported, thus subject to recall bias, and we did not assess the doses, frequency and duration of use of the various treatments to distinguish who has received adequate trials of treatment from those who did not. Previous studies have shown that individuals tend to over-report participation in exercise (47, 48) and that fewer than 10% of individuals who self-report using weight-loss strategies have consulted their family physician or a weight-loss specialist (49). When it comes to pharmacotherapy, in a study by Snijders and colleagues, while 75% of patients reported having previously tried acetaminophen, only 36% had used an adequate trial that they defined as 1000mg 2-4 times per day for at least 14 consecutive days (50). Therefore, our results are likely an *overestimate* of the proportion of individuals who have received adequate trials of these therapies. Third,

reported treatments may not reflect what health care providers actually prescribed and we acknowledge some heterogeneity across OA treatment guidelines (e.g. use of acetaminophen). Fourth, the cross-sectional nature of this study does not allow us to draw conclusions about causal associations between participant characteristics and use of treatments. Finally, whether improved use of non-surgical therapies for knee OA will lead to reduced need for TKA remains to be shown.

In conclusion, we found substantial underuse of recommended non-surgical treatments in knee OA patients recommended for TKA. Underuse was particularly high for non-pharmacological therapies, which have the greatest potential to improve symptoms (18) and are safe for use in patients with multi-morbidity. Implementation strategies are required to optimize non-surgical treatment of patients with knee OA before progressing to surgical treatment, particularly in older men and those with less education. Ultimately, improved use of non-surgical treatments has potential to delay or decrease need for TKA, increase health care system efficiency, reduce health care costs and improve patient outcomes.

ACKNOWLEDGEMENTS

Members of the BEST-Knee Research Team: Dr. Gillian A. Hawker (University of Toronto, Toronto, ON), Dr. Deborah A. Marshall (University of Calgary, Calgary, AB), Dr. Eric Bohm (University of Manitoba, Winnipeg, MB), Dr. Michael J. Dunbar (Dalhousie University, Halifax, NS), Dr. Peter Faris (University of Calgary, Calgary, AB), Dr. C. Allyson Jones (University of Alberta, Edmonton, AB), Dr. Tom Noseworthy (University of Calgary, Calgary, AB), Dr. Bheeshma Ravi (University of Toronto, Toronto, ON), Dr. Linda Woodhouse (University of Alberta, Edmonton, AB).

Edmonton Bone and Joint Centre, Edmonton, Alberta, Canada: participating study surgeons (Dr. Gordon Arnett, Dr. Robert Balyk, Dr. Jeffery Bury, Dr. John Cinats, Dr. Donald Dick, Dr. D'Arcy Durand, Dr. Lee Ekert, Dr. Don Glasgow, Dr. Robert Glasgow Sr. [deceased], Dr. Gordon Goplen, Dr. Ben Herman, Dr. Catherine Hui, Dr. Larry Hunka, Dr. Hongxing Jiang, Dr. William C. Johnson [deceased], Dr. Frank Kortbeek, Dr. Guy Lavoie, Dr. Mitch Lavoie, Dr. Paul K. Leung, Dr. James Mahood, Dr. Edward Masson, Dr. Richard McLeod, Dr. James McMillan [deceased], Dr. Greg O'Connor, Dr. David Otto, Dr. Carlo Panaro, Dr. Paulose Paul, Dr. Gordon Russell, Dr. Don Weber, Dr. Colleen Weeks, Dr. Andrea Woo [FP, screening]), clinic staff (Jane Squire Howden), and research staff (Anne-Marie Adachi, Jessica Beatty, Shakib Rahman, Braden Woodhouse).

Alberta Hip & Knee Clinic, Calgary, Alberta, Canada: participating study surgeons (Dr. Greg Abelseth, Dr. Kelley De Souza, Dr. John Donaghy, Dr. Paul Duffy, Dr. Kelly Johnston, Dr. Robert Korley, Dr. Raul Kuchinad, Dr. Michael Monument, Dr. Maureen O'Brien, Dr. James Powell, Dr. Shannon Puloski, Dr. Ed Rendall, Dr. Alex Rezansoff, Dr. Raj Sharma, Dr. James Stewart, Dr. Scott Timmerman, Dr. Jason Werle), clinic staff (Tanya Reczek), and research staff (Jeffrey Depew);

Bukky Dada (Department of Community Health Sciences, University of Calgary); Barbara Conner-Spady (Department of Community Health Sciences, University of Calgary); and Ian Stanaitis (Women's College Hospital/University of Toronto).

REFERENCES

1. Losina E, Thornhill TS, Rome BN, Wright J, Katz JN. The dramatic increase in total knee replacement utilization rates in the United States cannot be fully explained by growth in population size and the obesity epidemic. J Bone Joint Surg Am 2012;94:201-7.

2. Leskinen J, Eskelinen A, Huhtala H, Paavolainen P, Remes V. The incidence of knee arthroplasty for primary osteoarthritis grows rapidly among baby boomers: a population-based study in Finland. Arthritis Rheum 2012;64:423-8.

3. Stamp LK, Haslett J, Chapman P, O'Donnell J, Raja R, Rothwell A, et al. Rates of Joint Replacement Surgery in New Zealand, 1999-2015: A Comparison of Rheumatoid Arthritis and Osteoarthritis. J Rheumatol 2017;44:1823-7.

4. Hip and Knee Replacements in Canada, 2016–2017: Canadian Joint Replacement Registry Annual Report, 2018. Available from: https://www.cihi.ca/sites/default/files/document/cjrr-annual-report-2018-en.pdf.

5. Inacio MCS, Paxton EW, Graves SE, Namba RS, Nemes S. Projected increase in total knee arthroplasty in the United States - an alternative projection model. Osteoarthritis Cartilage 2017;25:1797-803.

6. Brander VA, Stulberg SD, Adams AD, Harden RN, Bruehl S, Stanos SP, et al. Predicting total knee replacement pain: a prospective, observational study. Clin Orthop Relat Res 2003(416):27-36.

7. Dickstein R, Heffes Y, Shabtai EI, Markowitz E. Total knee arthroplasty in the elderly: patients' self-appraisal 6 and 12 months postoperatively. Gerontology 1998;44:204-10.

8. NIH Consensus Statement on total knee replacement December 8-10, 2003. J Bone Joint Surg Am 2004;86-a:1328-35.

9. Gademan MG, Hofstede SN, Vliet Vlieland TP, Nelissen RG, Marang-van de Mheen PJ. Indication criteria for total hip or knee arthroplasty in osteoarthritis: a state-of-the-science overview. BMC Muscuoloskelet Disord 2016;17:463.

10. Hawker G, Bohm ER, Conner-Spady B, De Coster C, Dunbar M, Hennigar A, et al. Perspectives of Canadian Stakeholders on Criteria for Appropriateness for Total Joint Arthroplasty in Patients With Hip and Knee Osteoarthritis. Arthritis Rheumatol 2015;67:1806-15.

11. Frankel L, Sanmartin C, Conner-Spady B, Marshall DA, Freeman-Collins L, Wall A, et al. Osteoarthritis patients' perceptions of "appropriateness" for total joint replacement surgery. Osteoarthritis Cartilage 2012;20:967-73.

12. Frankel L, Sanmartin C, Hawker G, De Coster C, Dunbar M, Bohm E, et al. Perspectives of orthopaedic surgeons on patients' appropriateness for total joint arthroplasty: a qualitative study. J Eval Clin Pract 2016;22:164-70.

13. National Institute for Health and Clinical Excellence (NICE). Osteoarthritis Quality Standard; March 1, 2019. Available from: nice.org.uk/guidance/qs87.

14. Hochberg MC, Altman RD, April KT, Benkhalti M, Guyatt G, McGowan J, et al. American College of Rheumatology 2012 recommendations for the use of nonpharmacologic and pharmacologic therapies in osteoarthritis of the hand, hip, and knee. Arthritis Care Res (Hoboken) 2012;64:465-74.

15. Jordan KM, Arden NK, Doherty M, Bannwarth B, Bijlsma JW, Dieppe P, et al. EULAR Recommendations 2003: an evidence based approach to the management of knee osteoarthritis: Report of a Task Force of the Standing Committee for International Clinical Studies Including Therapeutic Trials (ESCISIT). Ann Rheum Dis 2003;62:1145-55.

16. National Institute for Health and Clinical Excellence: Osteoarthritis: Care and Management in Adults. London: National Institute for Health and Care Excellence (UK); 2014.

17. Jevsevar DS. Treatment of osteoarthritis of the knee: evidence-based guideline, 2nd edition. J Am Acad Orthop Surg 2013;21:571-6.

18. Bannuru RR, Osani MC, Vaysbrot EE, Arden N, Bennell K, Bierma-Zeinstra SMA, et al. OARSI guidelines for the non-surgical management of knee, hip, and polyarticular osteoarthritis. Osteoarthritis Cartilage 2019; S1063-4584(19)31116-1. [Epub ahead of print].

19. Abbate LM, Jeffreys AS, Coffman CJ, Schwartz TA, Arbeeva L, Callahan LF, et al. Demographic and Clinical Factors Associated With Nonsurgical Osteoarthritis Treatment Among Patients in Outpatient Clinics. Arthritis Care Res (Hoboken) 2018;70:1141-9.

20. Conaghan PG, Porcheret M, Kingsbury SR, Gammon A, Soni A, Hurley M, et al. Impact and therapy of osteoarthritis: the Arthritis Care OA Nation 2012 survey. Clin Rheumatol 2015;34:1581-8.

21. Porcheret M, Jordan K, Jinks C, Croft P. Primary care treatment of knee pain--a survey in older adults. Rheumatology (Oxford) 2007;46:1694-700.

22. Kingsbury SR, Hensor EM, Walsh CA, Hochberg MC, Conaghan PG. How do people with knee osteoarthritis use osteoarthritis pain medications and does this change over time? Data from the Osteoarthritis Initiative. Arthritis Res Ther 2013;15:R106.

23. Egerton T, Diamond LE, Buchbinder R, Bennell KL, Slade SC. A systematic review and evidence synthesis of qualitative studies to identify primary care clinicians' barriers and enablers to the management of osteoarthritis. Osteoarthritis Cartilage 2017;25:625-38.

24. Selten EMH, Vriezekolk JE, Nijhof MW, Schers HJ, van der Meulen-Dilling RG, van der Laan WH, et al. Barriers Impeding the Use of Non-pharmacological, Non-surgical Care in Hip and Knee Osteoarthritis: The Views of General Practitioners, Physical Therapists, and Medical Specialists. J Clin Rheumatol 2017;23:405-10.

25. Briggs AM, Houlding E, Hinman RS, Desmond LA, Bennell KL, Darlow B, et al. Health professionals and students encounter multi-level barriers to implementing high-value osteoarthritis care: a multi-national study. Osteoarthritis Cartilage 2019;27:788-804.

26. McHugh GA, Luker KA, Campbell M, Kay PR, Silman AJ. A longitudinal study exploring pain control, treatment and service provision for individuals with end-stage lower limb osteoarthritis. Rheumatology (Oxford) 2007;46:631-7.

27. Hofstede SN, Vliet Vlieland TP, van den Ende CH, Nelissen RG, Marang-van de Mheen PJ, van Bodegom-Vos L. Variation in use of non-surgical treatments among osteoarthritis patients in orthopaedic practice in the Netherlands. BMJ Open 2015;5:e009117.

28. Skou ST, Roos EM, Laursen MB, Rathleff MS, Arendt-Nielsen L, Rasmussen S, et al. Total knee replacement and non-surgical treatment of knee osteoarthritis: 2-year outcome from two parallel randomized controlled trials. O steoarthritis Cartilage 2018;26:1170-80.

29. Andersen RM. Revisiting the behavioral model and access to medical care: does it matter? J Health Soc Behav 1995;36:1-10.

30. Lubben J, Blozik E, Gillmann G, Iliffe S, von Renteln Kruse W, Beck JC, et al. Performance of an abbreviated version of the Lubben Social Network Scale among three European community-dwelling older adult populations. The Gerontologist 2006;46:503-13.

31. Kroenke K, Strine TW, Spitzer RL, Williams JB, Berry JT, Mokdad AH. The PHQ-8 as a measure of current depression in the general population. J Affect Disord 2009;114:163-73.

32. Bellamy N. Pain assessment in osteoarthritis: experience with the WOMAC osteoarthritis index. Semin Arthritis Rheum 1989;18:14-7.

33. Bellamy N, Buchanan WW, Goldsmith CH, Campbell J, Stitt LW. Validation study of WOMAC: a health status instrument for measuring clinically important patient relevant outcomes to antirheumatic drug therapy in patients with osteoarthritis of the hip or knee. J Rheumatol 1988;15:1833-40.

34. Perruccio AV, Stefan Lohmander L, Canizares M, Tennant A, Hawker GA, Conaghan PG, et al. The development of a short measure of physical function for knee OA KOOS-Physical Function Shortform (KOOS-PS) - an OARSI/OMERACT initiative. Osteoarthritis Cartilage 2008;16:542-50.

35. Gignac MA. An evaluation of a psychotherapeutic group intervention for persons having difficulty coping with musculoskeletal disorders. Soc Work Health Care 2000;32:57-75.

36. Gignac MA, Cott C, Badley EM. Adaptation to chronic illness and disability and its relationship to perceptions of independence and dependence. J Gerontology B Psychol Sci Soc 2000;55:P362-72.

37. Kadam UT, Croft PR. Clinical comorbidity in osteoarthritis: associations with physical function in older patients in family practice. J Rheumatol 2007;34:1899-904.

38. Roos EM, Arden NK. Strategies for the prevention of knee osteoarthritis. Nat Rev Rheum 2016;12:92-101.

39. Li LC, Sayre EC, Kopec JA, Esdaile JM, Bar S, Cibere J. Quality of nonpharmacological care in the community for people with knee and hip osteoarthritis. J Rheumatol 2011;38:2230-7.

40. Fransen M, McConnell S, Harmer AR, Van der Esch M, Simic M, Bennell KL. Exercise for osteoarthritis of the knee: a Cochrane systematic review. Br J Sports Med 2015;49:1554-7.

41. Rademakers J, Heijmans M. Beyond Reading and Understanding: Health Literacy as the Capacity to Act. Int J Environ Res Public Health 2018;15(8).

42. Nutbeam D. The evolving concept of health literacy. Soc Sci Med 2008;67:2072-8.

43. DiMatteo MR. Social support and patient adherence to medical treatment: a meta-analysis. Health Psych 2004;23:207-18.

44. Smink AJ, Bierma-Zeinstra SM, Schers HJ, Swierstra BA, Kortland JH, Bijlsma JW, et al. Non-surgical care in patients with hip or knee osteoarthritis is modestly consistent with a stepped care strategy after its implementation. Int J Qual Health Care 2014;26:490-8.

45. Vina ER, Cloonan YK, Ibrahim SA, Hannon MJ, Boudreau RM, Kwoh CK. Race, sex, and total knee replacement consideration: role of social support. Arthritis Care Res (Hoboken) 2013;65:1103-11.

46. Karlson EW, Daltroy LH, Liang MH, Eaton HE, Katz JN. Gender differences in patient preferences may underlie differential utilization of elective surgery. Am J Med 1997;102:524-30.

47. Tucker JM, Welk GJ, Beyler NK. Physical activity in U.S.: adults compliance with the Physical Activity Guidelines for Americans. Am J Prev Med 2011;40:454-61.

48. Garriguet D, Colley RC. A comparison of self-reported leisure-time physical activity and measured moderate-to-vigorous physical activity in adolescents and adults. Health Rep 2014;25:3-11.

49. Yoong SL, Carey ML, Sanson-Fisher RW, D'Este C. A cross-sectional study assessing the self-reported weight loss strategies used by adult Australian general practice patients. BMC Fam Pract 2012;13:48.

50. Snijders GF, den Broeder AA, van Riel PL, Straten VH, de Man FH, van den Hoogen FH, et al. Evidence-based tailored conservative treatment of knee and hip osteoarthritis: between knowing and doing. Scand J Rheumatol 2011;40:225-31.

Table 1. Participant characteristics (n=1273)

Characteristic	Overall (n=1273)	Prior use of recommended non-surgical treatments (n=1273)	
		Tried all (n= 760)	Did not try all (n=513)
Predisposing factors			
Age, years – mean (SD)	66.9 (8.7)	65.9 (8.4)	68.5 (9.1)*
Male – n (%)	508 (39.9)	238 (31.3)	270 (52.6)*
Annual income <$60,000 – n (%)	607/1117 (54.3)	353 (51.9)	254 (58.1)
< Post-secondary education – n (%)	555 /1259 (44.1)	297 (39.3)	258 (51.2)*
Not employed full time – n (%)	856/1261 (67.9)	500 (66.3)	356 (70.2)
Enabling factors			
Lubben Social Network score/30 – mean (SD)	17.6 (5.5)	17.8 (5.2)	17.3 (5.9)
Comorbid conditions			
BMI, kg/m^2 – mean (SD)	32.8 (6.3)	33.0 (6.6)	32.5 (6.0)
BMI ≥25 kg/ m^2 (overweight or obese) – n (%)	1174 (92.2)	683 (89.9)	491 (95.7)*
Heart disease – n (%)	181/1232 (14.7)	108 (14.6)	73 (14.8)
Hypertension – n (%)	670/1259 (53.2)	399 (53.1)	271 (53.4)
Diabetes – n (%)	207/1236 (16.8)	116 (15.6)	91 (18.4)
Gastrointestinal disease – n (%)	145/1232 (11.8)	98 (13.3)	47 (9.5)
Kidney disease – n (%)	31/1230 (2.5)	21 (2.9)	10 (2.02)
PHQ-8 depression/24 – median (IQR)	5.0 (2,10)	6.0 (3,11)	11.0 (9,13)*
Number of conditions^ – n (%)			
0	285/1266 (22.5)	168 (22.2)	117 (22.9)
1	413/1266 (32.6)	238 (31.5)	175 (34.3)
2	284/1266 (22.4)	165 (25.1)	119 (23.6)
≥ 3	284/1266 (22.4)	185 (17.6)	99 (14.9)
Need factors			
WOMAC pain/20 – mean (SD)	11.6 (3.5)	11.8 (3.5)	11.2 (3.5)*
KOOS-PS/100 – mean (SD)	53.6 (17.3)	54.5 (17.0)	52.2 (17.7)
Perceived OA coping efficacy/20 – mean (SD)	13.2 (3.9)	13.2 (3.8)	13.3 (3.9)
Non-surgical OA treatments used			
Non-pharmacologic treatments – n (%)			
Exercise	957/1269 (75.4)		
Physiotherapy	555/1254 (44.3)		
Weight loss (if BMI ≥25 kg/m^2)	807 /1167 (69.2)		
Recommended non-pharmacologic^ – n (%)	784/1273 (61.6)		

Pharmacologic treatments – n (%) Acetaminophen NSAIDs Knee injection **Any Pharmacologic$** – n (%)	 941/1252 (75.2) 953/1256 (76.0) 952/1267 (75.1) 1233/1272 (96.9)		
Recommended non-surgical knee OA treatment# – n (%)	760/1273 (59.7)		

* $p < 0.01$
^ Does not include other musculoskeletal coexisting conditions or depression
^ Exercise or physiotherapy plus weight loss if BMI ≥25 kg/m^2
$ Acetaminophen or NSAIDs or knee injection
Acetaminophen or NSAIDs or knee injection *and* exercise or physiotherapy *and* weight loss if BMI ≥25 kg/m^2

BMI, body mass index; OA, osteoarthritis, WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index; KOOS-PS, knee injury and osteoarthritis outcome score – physical function shortform; NSAID, non-steroidal anti-inflammatory, PHQ-8, eight-item patient health questionnaire depression scale

Table 2. The relationship of patient-level factors to prior use of recommended treatments (composite variable): results of logistic regression modeling

Independent variable	Dependent variable = Used recommended non-surgical knee OA treatment^	
	Unadjusted OR (95%CI)	**Adjusted OR (95%CI)***
Age, per year increase	**0.97 (0.95 – 0.98)**	**0.97 (0.95 – 0.99)**
Male sex (ref female)	**0.41 (0.33 – 0.52)**	**0.33 (0.25 – 0.45)**
< Post-secondary education (ref post-secondary)	**0.62 (0.49 – 0.78)**	**0.70 (0.53 – 0.93)**
Not employed full time (ref employed)	0.84 (0.66 – 1.07)	0.92 (0.65– 1.29)
Annual income <$60,000 (ref ≥$60,000)	0.78 (0.61 – 0.99)	0.75 (0.55 – 1.02)
Lubben social network score, per unit increase	1.01 (0.99 – 1.04)	**1.03 (1.00 – 1.06)**
BMI, per unit increase	1.01 (0.99 – 1.03)	0.99 (0.97 – 1.01)
Heart disease	0.99 (0.72 – 1.36)	**1.64 (1.09 – 2.48)**
Hypertension	0.99 (0.79 – 1.24)	1.10 (0.82 – 1.48)
Diabetes	0.82 (0.61 – 1.11)	0.89 (0.61 – 1.30)
Kidney disease	1.42 (066 – 3.05)	2.09 (0.83 – 5.28)
Gastrointestinal disease	1.47 (1.02 – 2.13)	**1.64 (1.04 – 2.58)**
PHQ-8, per 1 unit	**1.04 (1.02 – 1.06)**	**1.06 (1.03 – 1.09)**
WOMAC pain, per 1 unit	**1.05 (1.02 – 1.08)**	1.01 (0.96 – 1.07)
KOOS-PS, per 1 unit	**1.01 (1.00 – 1.01)**	1.00 (0.99 – 1.01)
Perceived OA coping efficacy, per 1 unit	0.99 (0.96 – 1.02)	1.00 (0.96 – 1.05)

^ Having tried exercise or PT, *and* weight loss if overweight or obese (BMI ≥25 kg/m^2) *and at least one of* acetaminophen, oral or topical NSAIDs or joint injection
*model: goodness of fit p=0.82; c-statistic = 0.70.
Bold font denotes statistical significance p<0.05

BMI, body mass index; OA, osteoarthritis, WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index; KOOS-PS, knee injury and osteoarthritis outcome score – physical function shortform; NSAID, non-steroidal anti-inflammatory, PHQ-8, eight-item patient health questionnaire depression scale

Table 3. The relationship of patient-level factors to prior use of non-pharmacological treatments: results of logistic regression modeling.

Independent variable	Dependent variable = Used non-pharmacological treatment^	
	Unadjusted OR (95%CI)	**Adjusted OR (95%CI)***
Age, per year increase	**0.97 (0.96 – 0.98)**	**0.98 (0.96 – 1.00)**
Male sex (ref female)	**0.47 (0.36 – 0.58)**	**0.38 (0.28 – 0.50)**
< Post-secondary education (ref post-secondary)	**0.58 (0.46 – 0.74)**	**0.66 (0.50 – 0.88)**
Not employed full time (ref employed)	0.87 (0.68 – 1.01)	0.97 (0.69– 1.36)
Annual income <$60,000 (ref ≥$60,000)	**0.66 (0.49 – 0.88)**	**0.71 (0.52 – 0.96)**
Lubben social network score, per unit increase	1.02 (1.00 – 1.04)	**1.03 (1.01 – 1.06)**
BMI, per unit increase	1.01 (0.99 – 1.03)	0.99 (0.97 – 1.01)
Heart disease	1.05 (0.76 – 1.45)	**1.70 (1.12 – 2.57)**
Hypertension	0.92 (0.74 – 1.16)	1.00 (0.74 – 1.34)
Diabetes	0.83 (0.61 – 1.12)	0.94 (0.64 – 1.38)
Kidney disease	1.32 (0.62 – 2.83)	1.90 (0.75– 4.80)
Gastrointestinal disease	**1.57 (1.08 – 2.29)**	**1.79 (1.13 – 2.85)**
PHQ-8, per 1 unit	**1.04 (1.02 – 1.06)**	**1.06 (1.02 – 1.09)**
WOMAC pain, per 1 unit	**1.04 (1.01 – 1.08)**	1.01 (0.96 – 1.07)
KOOS-PS, per 1 unit	**1.01 (1.00 – 1.01)**	1.00 (0.99 – 1.01)
Perceived OA coping efficacy, per 1 unit	1.00 (0.97 – 1.02)	1.01 (0.97 – 1.05)

^ Having tried exercise or PT, *and* weight loss if overweight or obese (BMI ≥25 kg/m^2)
*model: goodness of fit p=0.29; c-statistic =0.69.
Bold font denotes statistical significance p<0.05

BMI, body mass index; OA, osteoarthritis, WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index; KOOS-PS, knee injury and osteoarthritis outcome score – physical function shortform; NSAID, non-steroidal anti-inflammatory, PHQ-8, eight-item patient health questionnaire depression scale

Table 4. Relationship of patient-level factors to prior use of non-steroidal anti-inflammatories (NSAIDs): results of logistic regression modeling.

Independent variable	Dependent variable = Used NSAIDs	
	Unadjusted OR (95%CI)	**Adjusted OR (95%CI)***
Age, per year increase	**0.95 (0.93 – 0.96)**	**0.97 (0.94 – 0.99)**
Male sex (ref female)	**0.72 (0.55 – 0.93)**	**0.68 (0.48 – 0.94)**
< Post-secondary education (ref post-secondary)	**0.75 (0.58 – 0.97)**	0.83 (0.60 – 1.14)
Not employed full time (ref employed)	**0.53 (0.39– 0.71)**	0.80 (0.53 – 1.20)
Annual income <$60,000 (ref ≥$60,000)	**0.75 (0.59 – 0.96)**	0.91 (0.64 – 1.30)
Lubben social network score, per unit increase	0.99 (0.96 – 1.01)	0.98 (0.95 – 1.01)
BMI, per unit increase	**1.02 (1.00 – 1.04)**	1.00 (0.97 – 1.02)
Heart disease	**0.50 (0.39 – 0.71)**	0.70 (0.45 – 1.06)
Hypertension	0.81 (0.62 – 1.06)	1.05 (0.76 – 1.43)
Diabetes	**0.58 (0.42 – 0.81)**	0.69 (0.46 – 1.05)
Kidney disease	**0.37 (0.18 – 0.76)**	0.45 (0.20 – 1.04)
Gastrointestinal disease	1.14 (0.75 – 1.74)	1.37 (0.80 – 2.34)
PHQ-8, per 1 unit	1.00 (0.98 – 1.03)	0.98 (0.95 – 1.02)
WOMAC pain, per 1 unit	1.03 (0.99 – 1.07)	0.99 (0.93 – 1.06)
KOOS-PS, per 1 unit	1.01 (1.00 – 1.02)	1.01 (0.99– 1.02)
Perceived OA coping efficacy, per 1 unit	1.00 (0.96 – 1.03)	0.97 (0.93 – 1.04)

*model: goodness of fit p= 0.55; c-statistic = 0.67.
Bold font denotes statistical significance p<0.05

BMI, body mass index; OA, osteoarthritis, WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index; KOOS-PS, knee injury and osteoarthritis outcome score – physical function shortform; NSAID, non-steroidal anti-inflammatory, PHQ-8, eight-item patient health questionnaire depression scale

Figure 1. Conceptual framework for receipt of recommended non-surgical osteoarthritis treatments.