Title: Effect of Sociodemographic Factors on Surgical Consultations and Hip or Knee Replacements among Patients with Osteoarthritis in British Columbia, Canada

Running head: SES, surgical consultation and TJA for OA patients

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Abstract

Objectives

To quantify the effect of demographic variables and socioeconomic status (SES) on surgical consultation and total joint arthroplasty (TJA) rates among osteoarthritis (OA) patients, using population-based administrative data.

Research Design

A cohort study was conducted in British Columbia using population data from 1991 to 2004. From April 1996 to March 1998, we have documented 34,420 new OA patients and these patients were followed to March 2004 for their first surgical consultation and TJA. Effects of age, sex, and SES were evaluated by Cox proportional hazards models after adjusting for co-morbidities and pain medication used.

Results

During a mean 5.5 year follow up period, 7,475 OA patients had their first surgical consultations and 2,814 patients received TJA within a 6 years mean follow up period. Crude hazards ratio (HR) for men compared to women was 1.25 (95% CI, 1.20-1.31) for surgical consultation and was 1.14 (95% CI, 1.06-1.23) for TJA. The interaction between sex and SES was significant. Stratified analysis showed among men, HR of 1.42 (95% CI, 1.27-1.58) and 1.52 (95% CI, 1.26-1.83) for surgical consultations and TJA respectively for the highest SES compared with the lowest SES quintiles. Similar significant results were observed among women.

Conclusions

Differential access to the health care system exists among patients with OA. Women with OA were less likely than men to see an orthopedic surgeon as well as to obtain a TJA. Patients with higher SES consulted orthopedic surgeons more frequently and received more TJA than those with the lowest SES.

Keywords: osteoarthritis, knee replacement arthrotplasty, hip replacement arthroplasty, total joint arthroplasty, socioeconomic factors**.**

Introduction

Osteoarthritis (OA) of the hip and knee is the most common type of arthritis and the leading cause of long-term disability.[1-3] OA has a higher prevalence in older age groups and women are more commonly affected than men.[4, 5] Although treatment of OA is symptomatic with most cases treated conservatively using medications or non-pharmacological modalities such as exercise, total joint arthroplasty (TJA) is a cost-effective treatment option for end-stage knee and hip OA.[6-9]

From a clinical point of view, the most important indication for surgery in a patient with OA is pain that is not relieved by medication and is affecting function and quality of life.[10] However, not all patients who would benefit from surgical treatment get TJA.[1, 11] Several studies have been conducted in Canada and in the USA to determine the predictors of TJA in OA patients. Among these, severe pain, disability, willingness to undergo TJA, geographic region, sex, race and socioeconomic status (SES) were significant.[11-16] Data from Canadian Joint Replacement Registry[17] demonstrates that women receive more TJA than men and have a significantly higher rate per 100,000 patients using age and sex matched data. Patients' willingness to undergo TJA was not related to SES after adjusting for age, sex and region.[11]

Understanding the association between SES and TJA among patients with OA is important for the optimal provision of health services in this very large group of patients. One of the primary goals of the Canadian Medicare is to provide universal access to all necessary health care services and thus reduce any inequalities attributable to income and education.[18-20] In British Columbia (BC), the setting for this study, access to physician services is managed under the auspices of the Medical Services Plan (MSP) and is publicly funded health insurance program with first-dollar coverage for

all services. Similarly, in-hospital services are also provided free-of-charge by the Hospital Programs division of the Ministry of Health Services. Patients registered with the MSP may self-refer for primary health care service to their General Practitioner (GP); however, for a specialist visit, such as visit to an orthopedic surgeon, patients require a referral from GP. Since physicians' perceptions of patients can be influenced by patients' socio-demographic characteristics[21], such factors may have an impact on who is referred to a specialist and who is not. In previous Canadian studies, self-reported visits to GP were strongly influenced by a person's need for medical care; however, patients with higher SES used more specialist services.[11, 22]

There are no previous population-based prospective studies of the role of socio-demographic factors in getting referrals from GP to orthopedic surgeons as well as undergoing TJA in patients with OA. The objective of this study was to determine the effects of age, sex and SES on the rates of first surgical consultation and first TJA among patients diagnosed with OA.

Materials and Methods

Study population

We used the administrative database collected and maintained by the BC Ministry of Health for the reimbursement of physician visits covered by MSP from April 1991 through March 2004 and hospital admissions records from Hospital Programs for the same fiscal years. From data for the entire province we created the BC Musculoskeletal cohort of approximately 3.5 million subjects with any musculoskeletal diagnosis in the above mentioned period. The database also covers all prescriptions through PharmaCare of all residents age 65 and older.

Exposure assessment

OA patients were identified using the case definition of at least two visits to a health professional in two years or one discharge from the hospital with an ICD-9 (International Classification of Disease, 9th Revision) code of 715 (Osteoarthrosis and related disorders). A visit was defined as any service with the exclusion of diagnostic procedures and certain other procedures, such as dialysis/transfusion, anesthesia, obstetrics, or therapeutic radiation. Visits to all types of health professionals were included, and the date of diagnosis was coded as the date of the second health professional visit or the date of discharge from hospital. The database contains information regarding date and type of service, physician's specialty code, birth and death dates, sex, SES, and MSP registration start and exit dates. The Population Data BC includes postal codes for all residents registered with the Ministry of Health, as recorded in June of each year. These postal codes were used to determine neighbourhood-level income quintiles (SES quintile) based on a methodology developed at Statistics Canada using census data.[23, 24] Therefore, SES was assigned based on residential address linked to census data at the level of enumeration area (one or more adjacent blocks, up to 650 dwellings) and was grouped into 5 income quintiles, from 1 (lowest) to 5 (highest), based on mean household income of those residents.

Outcomes

Surgical consultations or visit to orthopedic surgeons were assessed by checking the physician's specialty codes. Up to 25 diagnosis codes and a maximum of 12 procedure codes [Canadian Classification of Diagnostic, Therapeutic and Surgical Procedures (CCP) code] were provided for each admission date on hospital discharge summaries. Total hip and total knee replacement surgery cases were identified using the procedure codes 935 and 934.1 respectively. We excluded all surgeries with codes at the time of surgery for injury or poisoning (ICD-9 800-995, 997 and 999), neoplasm other than benign (ICD-9 140-208 and 235-239) and non-medical external causes of injury

(ICD-9 E800-869 E880-E928, E950-E999). Revision procedures were excluded by identifying cases having the above two procedure codes with an ICD-9 code of 730 (infections), 996.4, 996.5, 996.6, 996.7 or 998 (complications of certain surgical procedures) in the same hospital discharge record.[25]

Study design

The study population consisted of patients with OA who were 20 years of age or older. The outcome "surgical consultation" was defined as the first visit to an orthopedic surgeon. The event time for each patient was calculated in months from the date of OA diagnosis. All OA patients were identified using the above case definition from 1991, and a cohort of new OA patients were defined as those meeting our case definition in the two fiscal years from April 1996 to March 1998, after deleting the prevalent cases. These cases were followed until March 2004. By doing so, we ensured that all patients were followed within the same medical care system during a similar time period. Separate analyses were carried out for time to first visit to an orthopedic surgeon (surgical visit) and time to TJA. Patients were followed till they had these events, died, withdrew from MSP registration, or at the end of observation time 2004, whichever came first. Patients' age, SES, and co-morbidities were assessed at the time of OA diagnosis.

Statistical Analysis

Out of all newly diagnosed adult OA cases from April 1st 1996 to March 31st 1998, we had complete information of all variables of interest for 34,420 patients. Separate analyses were carried out for time to first surgical consultation and time to first TJA. Age, sex and SES quintile were used as predictors for both analyses. All analyses were adjusted for co-morbidities which were obtained from the ICD-9 diagnosis codes on or before the OA diagnosis. We calculated the Charlson co-morbidity score[26, 27] for all subjects in the study. The Charlson score contains 19 categories of co-morbidity and each category of disease has a weight. Total score for each patient was calculated by adding the weights

for each condition. In addition, we identified all patients with a diagnosis of diabetes, hypertension, or ischemic heart disease. The effect of each predictor was evaluated using the Cox proportional hazards (PH) models. Multivariable Cox PH models were fitted and the hazard ratios, 95% confidence intervals, and the p-values were reported. The proportionality assumptions for PH models were checked by observing the Kaplan-Meier curves of the survival function versus the survival time, and the graph of the log [-log (survival function)] versus log of survival time.[28] SAS version 9.1 was used throughout the study to perform the analyses.[29]

Results

Surgical consultations

In two years 13,571 men and 20,849 women were diagnosed with OA by physicians other than orthopedic surgeons. The distribution of these patients by sex, age, SES, and co-morbid conditions is presented in Table 1. The mean age at diagnosis was 62 with standard deviation (SD) of 14.8 years. Forty five percent of the patients were classified as low SES (quintiles 1 and 2), 18% as high SES (quintile 5) and the rest with moderate SES (quintiles 3 and 4). Eleven percent of the patients had diabetes, 36% diagnosed with hypertension, 23% had a history of ischemic heart disease on or before OA diagnosis, and the mean Charlson co-morbidity score was 1.63 (SD, 2.3).

During the 5.5 years of mean follow up period, 7,475 persons diagnosed with OA had their first surgical consultations which translated into 39 new consultations per 1,000 person years. Hazards ratios (HR) and 95% confidence intervals (CI) from univariable analyses are shown in Table 2. The surgical consultation rate in persons diagnosed with OA was significantly higher for men than for women, with HR of 1.25 (95% CI, 1.20-1.31). The average age of patients having an orthopedic

surgeon visit was 63 years (SD, 12.9). Age and SES showed significant relationships with time to the first orthopedic surgeon visit. Significant interaction was observed between sex and SES ($p < 0.01$), and between sex and age ($p=0.02$). Consequently, stratified analyses were performed using multivariable PH regression separately for men and women after adjusting for diabetes, hypertension, ischemic heart disease, and Charlson co-morbidity score (Table 3). Among men SES quintile showed a significant and monotonically increasing relationship with the first orthopedic surgeon visit. HR increased from 1.14 (95% CI 1.02-1.27) in quintile 2 to 1.42 (1.27-1.58) in quintile 5 (highest SES) compared with the lowest SES quintile. Among women HR was 1.14 (95% CI, 1.04-1.25) and 1.19 (95% CI, 1.09-1.31) for SES quintiles 4, and 5 respectively compared to SES quintile 1. HR increased from 0.75 (95% CI, 0.62-0.92) in age 20-39 to 1.42 (95% CI, 1.22-1.65) in age 70-79 compared with age ≥ 80 among men, and among women HR increased from 0.50 (95% CI, 0.41-0.60) in age group 20-39 to 1.30 (95% CI, 1.16-1.45) in age group 70-79 compared with age ≥ 80.

TJA

The distribution of 1,187 men and 1,627 women who had their first TJA during 6 years of mean follow-up time is presented in Table 1. The mean age was 66 (SD, 10.6) years. The distribution of patients ranged from 18% to 22% in 5 different SES groups. Among these patients, 10% had diabetes, 43% patients were suffering from hypertension and 24% patients were diagnosed with ischemic heart diseases on or before OA diagnosis, and the mean Charlson co-morbidity scores were 1.71 (SD, 2.2). We observed that OA patients received 13 new TJA per 1,000 person years. Crude HR and 95% confidence intervals estimated from PH regression were shown in Table 2. HR was 1.14 (95% CI, 1.06-1.23) for men compared with women. In the crude analyses, both age and SES showed

significant association with TJA. Compared to age ≥ 80, age group 60-69 had HR of 1.48 (95% CI, 1.29-1.70) and age group 70-79 had HR of 1.63 (95% CI, 1.42-1.88).

Because of significant interactions between sex and SES ($p < 0.01$), and between sex and age ($p=0.03$), multivariable PH regression analyses were performed separately for men and women, after adjusting for diabetes, hypertension, ischemic heart disease, and Charlson co-morbidity score (Table 3). Among men HR increased from 1.17 (95% CI, 0.97-1.42) in SES quintile 2 to 1.52 (95% CI, 1.26-1.83) in SES quintile 5 compared with the lowest SES quintile and among women HR increased from 0.99 (95% CI, 0.85-1.16) in quintile 2 to 1.34 (95% CI, 1.16-1.56) in quintile 5. HR increased from 0.15 (95% CI, 0.09-0.24) in age group 20-39 to 1.52 (95% CI, 1.21-1.91) in age group 70-79 among men, and among women HR increased from 0.23 (95% CI, 0.15-0.34) in age group 20-39 to 1.64 (95% CI, 1.37-1.97) in age group 70-79 compared with age ≥ 80.

Discussion

We investigated the demographic and socio-economic factors that may influence the rate of the first orthopedic surgeon visit and the rate of the first TJA in patients with OA using an administrative database. We found that male patients visited surgeons at a higher rate than female patients. After adjusting for age, sex, and co-morbid conditions, patients with higher SES were more likely to see a surgeon as well as to obtain a TJA compared to patients with a lower SES.

In Canada, a referral from the family physician is usually necessary to see a specialist. Several studies have looked at the relationship between SES and utilization of physician services. Using the National Population Health Survey data, Dunlop et al.[20] and Humphries et al.[19] found that Canadians with

lower income and education were less likely to visit specialists than those with moderate or high income and higher education. Langley et al.[30] observed that the patients' wishes (or willingness) were significant factors in getting a referral from a GP to a specialist. Our results show that OA patients received referrals to an orthopedic surgeon in an average of 39 per 1000 person years, and patients with high SES had significantly higher rate of referrals, which coincide with the results of the above studies.

Hawker et al.[11] found a greater potential need for hip or knee replacement among individuals with less education and low income. They also found that the patient's willingness to consider joint replacement does not differ due to SES levels. In another study, Hawker et al.[16] found that when willingness was dropped from the model, patient's education became a significant predictor of TJA. The above studies did not address the time from diagnosis to surgical consultation. We observed that after diagnosis, only 13 patients had their first TJA in an average of 1,000 person years, and this suggests that two thirds of the referrals did not receive their TJA.

Women were less likely to be recommended by their physicians for total knee arthroplasty compared to men and consequently women have lower rates of replacement surgeries than men after adjusting for medical factors.[1, 31] Possible reasons for this sex differences are could be due to primary care providers' views regarding the risks of, indications for, and expected outcomes of arthroplasty that made them consider women less appropriate candidates for surgery than men.[1] Other possibilities for sex differences may include, for women, caregiver status i.e. older women often live alone or are primary caregivers to their spouses.[32] In addition heavy labor occupations and high demand sports are well established risk factors for osteoarthritis.[33-35] These factors might contribute to sex differences in

getting surgical consultations and TJA. Our results are consistent with this hypothesis and show that the difference is due to a lower rate of referrals to orthopedic surgeons among women diagnosed with OA. Another interesting finding from our study was the SES and gender interaction. Men in the highest SES group were 42% more likely to obtain a surgical consultation and 52% more likely to undergo TJA than men in the lowest SES group, whereas among women the highest SES group had only 19% more surgical consultations and 34% more TJA compared with the lowest SES group. The reasons for this interaction between SES and sex may include both medical and other social factors. It is also possible that, compared to men, women diagnosed with OA are less often perceived as appropriate candidates for TJA by the GP. Although significant interaction was found between age and gender, we observed that both men and women had monotonically increasing rates of surgical consultations and TJA as age increased.

One of the limitations of this study is that both false negatives and false positives may occur due to wrong diagnosis or incorrect recording in the administrative forms. Harrold, et al.[36] estimated the positive predictive value of administratively coded OA in the general population at 62%. We have tried to minimize false negatives and false positives by using a case definition which requires 2 office visits for OA in two years. In our data SES was assigned based on the average household income in the patient's neighborhood (census enumeration area), this may subject to potential non-differential misclassification. A validation study was done in the province of Manitoba by Mustard et al.[37] examining the measurement validity of ecologic SES measures (i.e. neighborhood-level income) as proxies for individual-level measures. They reported that risk estimates derived from ecologic income measures were not attenuated relative to risk estimates from individual measures of household income, thus providing evidence supporting the use of ecologic-level income measures.

Our study is based on prospective, complete data from a very large, geographically defined cohort of patients, followed for a long period of time. We used the same large population-based database as described in a previous paper by Kopec et al.[5] that captured the incidence and prevalence of osteoarthritis in BC by age and sex. In BC, observed prevalence of osteoarthritis was 6% using case definition that requires at least 2 visits to a health professional within 2 years or one hospital separation with ICD-9 code 715[5]. The estimate was also comparable with previous large population-based studies, viz. Felson et al.[4] where prevalence was 9% among 30 and above aged population and Harrold et al.[36] where prevalence was 8.7%. Data on the prevalence of TJA among osteoarthritis patients are limited. CJRR estimated that TJA in BC was 2.6 per 1000 population in 2006-07 and 1.3 per 1000 population in 1996-97. In our cohort, we have found 1.9 TJA per 1000 individuals in 2003-04. The database covered years from April 1991 to March 2004. The reason for selecting new OA patients from April 1996 to March 1998 was to ensure 5 years (1991 - 1996) of run-in time, i.e., observation time needed to exclude prevalent cases. This was justified by another previous analysis of the BC administrative database[5], which determined that the incidence rate of OA depended on the number of run-in years but after 5 years this effect became minimal. Thus, patients in our study were followed for a maximum of 8 years from diagnosis to the first surgical consultation or to the first TJA. By observing time from OA diagnosis to surgical consultations and to surgery, we were able to get additional insight into the process of surgical care for OA patients and more precise inferences regarding the factors influencing the rates of orthopedic surgeon visits and surgery.

Studies performed in the USA, Canada, and UK found similar relationships with SES and TJA, mainly patients with low income had TJA less frequently compared to patients with higher SES.

After analyzing US Medicare data, Mahomed et al.[38] showed that the blacks and individuals with low income had a significantly lower rate of total knee replacement than the individuals with high income. From a study conducted with patients in England and Ontario, Hawker et al.[39] found variations in knee arthroscopy rates according to patient's income. Steel et al.[40] concluded that women and other low income people living in Northern England, received relatively less hip and knee joint replacements. These findings are also evident in other surgical procedures such as cardiac[41], kidney transplant,[42] and melanoma treatment.[43] Furthermore, low SES has been shown to an increasing influence in the rate of operative mortality.[44] Several studies also explored why and how SES might affect individual health[45, 46] and health care provision.[47-50]

This database also covers all prescriptions for those aged 65 and older and is electronically linked to MSP data. The effects of prescribed pain relief medications, such as acetaminophen, non-steroidal anti-inflammatory drugs (NSAIDs) and opioids were adjusted for by using data from the BC Pharmacare database. We repeated the same analyses for patients age 65 and above where all the pain medications were adjusted for. Because we did not have data for the disease severity, adjusting for the drug use also controls for the possible bias in the results from the severity of the disease. Even though we have adjusted for the prescription pain relief medications, the hazards ratios for age, sex and SES remained the same.

In conclusion, despite BC's prepaid universal healthcare system, there was a significant difference between OA patients with low vs. high SES in getting referrals to orthopedic surgeons and in the rate of obtaining the first TJA. SES differentials were higher among men, compared to women. After an OA diagnosis, women were less likely to see a surgeon than men as well as less likely to obtain hip or

knee replacement surgeries. These results suggest that socio-demographic factors play a significant role in determining access to surgical care for OA in British Columbia. Our results are likely generalizable to other Canadian provinces but their generalizability to other countries, with different health care systems, requires further research.

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Table 1: Socio-demographic characteristics of incident osteoarthritis patients from April 1996 to March 1998, their first orthopedic surgeons' visit, and their first total joint arthroplasty. The numbers are percentage unless otherwise mentioned.

Characteristics	New OA diagnosis by non orthopedic surgeon (n=34,420)	First orthopedic surgeon visit (n= 7,475)	First total joint arthroplasty (n=2,814)
Women n (%)	20,850 (61)	4,198 (56)	1,627 (57.8)
Mean age (± SD) years	61.6 (± 14.8)	63 (± 12.9)	66 (±10.6)
Socioeconomic Status (SES)			
SES quintile 1	24	21	19
SES quintile 2	20.5	19	18
SES quintile 3	19	20	20
SES quintile 4	18.5	20	21
SES quintile 5	18	20	22
Age			
20-39	8.4	5	1.7
40-49	13.3	10.8	5.5
50-59	21.0	22	15.7
60-69	23.7	28.2	34.3
70-79	22.7	26	34.1
80+	10.9	8.5	8.7
Diabetes	11	10	10
Hypertension	36	38	43
Ischemic heart disease	23	23	24
Mean Charlson co-morbidity score (± SD)	1.63 (± 2.3)	1.60 (± 2.2)	1.71 (± 2.2)

Table 2: Crude hazard ratios (HR) and confidence intervals for surgical consultations and for total joint arthroplasty among new osteoarthritis patients.

Variable	Surgical consultation HR (95% CI)	p-value	Total joint arthroplasty HR (95% CI)	p-value
Sex				
Men	1.25 (1.20, 1.31)	< 0.01	1.14 (1.06, 1.23)	< 0.01
Women	1.00 (reference)		1.00 (reference)	
Socioeconomic Status (SES)				
SES quintile 1	1.00 (reference)		1.00 (reference)	
SES quintile 2	1.07 (0.99, 1.15)	0.07	1.09 (0.96, 1.22)	0.18
SES quintile 3	1.19 (1.11, 1.28)	< 0.01	1.28 (1.14, 1.44)	< 0.01
SES quintile 4	1.26 (1.18, 1.35)	< 0.01	1.37 (1.22, 1.54)	< 0.01
SES quintile 5	1.33 (1.24, 1.43)	< 0.01	1.50 (1.34, 1.68)	< 0.01
Age				
20-39	0.62 (0.55, 0.71)	< 0.01	0.19 (0.14, 0.26)	< 0.01
40-49	0.88 (0.80, 0.98)	0.02	0.41 (0.33, 0.50)	< 0.01
50-59	1.14 (1.04, 1.26)	< 0.01	0.74 (0.63, 0.86)	< 0.01
60-69	1.36 (1.24, 1.49)	< 0.01	1.48 (1.29, 1.70)	< 0.01
70-79	1.36 (1.24, 1.49)	< 0.01	1.63 (1.42, 1.88)	< 0.01
80+	1.0 (reference)		1.0 (reference)	

Table 3: Adjusted hazard ratios (HR) for surgical consultation and for total joint arthroplasty, stratified analysis by sex.

Variable	Surgical consultation HR (95% CI)*		Total joint arthroplasty HR (95% CI)*	
Sex	Men	Women	Men	Women
Socioeconomic Status (SES)				
SES quintile 1	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
SES quintile 2	1.14 (1.02, 1.27)	1.00 (0.91, 1.09)	1.17 (0.97, 1.42)	0.99 (0.85, 1.16)
SES quintile 3	1.31 (1.18, 1.47)	1.07 (0.98, 1.18)	1.42 (1.18, 1.72)	1.11 (0.95, 1.29)
SES quintile 4	1.38 (1.23, 1.53)	1.14 (1.04, 1.25)	1.50 (1.25, 1.81)	1.23 (1.05, 1.43)
SES quintile 5	1.42 (1.27, 1.58)	1.19 (1.09, 1.31)	1.52 (1.26, 1.83)	1.34 (1.16, 1.56)
Age				
20-39	0.75 (0.62, 0.92)	0.50 (0.41, 0.60)	0.15 (0.09, 0.24)	0.23 (0.15, 0.34)
40-49	1.02 (0.86, 1.22)	0.76 (0.66, 0.87)	0.38 (0.28, 0.52)	0.40 (0.30, 0.52)
50-59	1.25 (1.07, 1.47)	1.04 (0.92, 1.18)	0.68 (0.53, 0.88)	0.73 (0.59, 0.90)
60-69	1.41 (1.21, 1.64)	1.29 (1.16, 1.45)	1.29 (1.02, 1.62)	1.55 (1.29, 1.85)
70-79	1.42 (1.22, 1.65)	1.30 (1.16, 1.45)	1.52 (1.21, 1.91)	1.64 (1.37, 1.97)
80+	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)

*HR was adjusted for diabetes, hypertension, ischemic heart disease, and Charlson Comorbidity index.