The Relationship between Socioeconomic Status and Timely Access to and Outcomes of Knee and Hip Replacements in Select Canadian Provinces

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Abstract

Some international literature has shown that individuals with higher socioeconomic status enjoy more timely access to and better post-operative outcomes from joint replacement procedures than individuals from lower socioeconomic status. However, there are no known pan-Canadian studies to date that have reported similar findings. Using patient-level data from the Canadian Institute for Health Information's Discharge Abstract Database and Canadian Joint Replacement Registry, and Statistics Canada's income quintiles, I studied whether socioeconomic status is correlated with timely access (wait-time) to and outcomes (total length of stay) of elective joint replacement procedures. I found that patients belonging to the richest income quintile waited over 3% less (approximately 7 days) than all others. I also found that the patients in the highest income quintile experience 7% shorter hospital stays (approximately half a day) than those in the lowest income quintile. There was a clear evidence of disparity in access to and outcome of joint replacement procedures based on socioeconomic status in Canada. In the future, having data on hospital-related characteristics, such as location and size, could provide further insight on this topic.

1. Introduction

Hip replacement (HR) and knee replacement (KR) procedures are considered clinically- and cost-effective treatments for reducing joint pain and enhancing quality of life (Cipriano *et al.* 2007). These procedures may also offer economic benefits such as 'steady' income from normal work routine and social benefits such as increased participation in community-related activities. According to the Canadian Institute for Health Information (2008), in 2006–2007, more than 62,000 hospitalizations in Canada were for HR and KR procedures with an average wait-time of 127 days and 169 days, respectively.

In countries with universal health coverage, socioeconomic status (SES) is not expected to influence access to and outcomes of elective joint replacement (JR) procedures.[1] According to Hamilton *et al.* (1996), and based on the review of recent Canadian literature, there are no known Canadian studies that have reported differences in timely access to care across income classes for specific clinical

[1] Elective procedures refer to procedures that are scheduled in advance as opposed to those that are conducted as a result of an emergency (such as a fracture). In this paper, JR refers to elective procedures unless otherwise indicated.

procedures (such as JR), along with socioeconomic variation in post-treatment outcomes.[2] Yet, there is ample literature from certain European countries and Australia, where healthcare coverage is universal, that shows substantial variation in access to and outcomes of JR procedures based on various measures of SES.[3] While it's difficult to generalize the results of these studies, they point to negative correlation between SES and access to as well as outcome of JR procedures.

In the last decade in Canada, HR and KR procedures have received substantial attention from politicians, policy makers and health system managers. First, reduction in wait-time for JR procedures has been one of the key priorities within the Canadian healthcare system.[4] Based on the 2004 Healthcare Accord, JR procedures are one of the five priority areas that the federal government directly targets for meaningful reductions in wait times (CIHI, 2008).[5] Secondly, healthcare stakeholders have simultaneously targeted improvement in the outcomes of JR procedures give that these procedures significantly impact the quality of life of patients and the overall resource allocation within the healthcare system. Given the significance of JR procedures from the perspective of Canadian public as well as the policy makers, a key question to ask is: Unlike the European and Australian public healthcare systems, is the Canadian healthcare system equitable in terms of access to and outcomes of JR procedures?

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[2] Hamilton *et al.* (1996) studied fracture-related urgent joint replacement surgeries in Quebec and showed that patients from higher income postal-codes only experience slightly shorter delays, and that income has no substantial correlation with post-surgery outcomes.

[3] While some of the European countries and Australia do offer universal healthcare coverage to their citizens, there are some differences between these countries and Canada. For example: some of the European countries 9such as England and Sweden) do offer their citizens an option of purchasing a supplemental insurance for private healthcare services. Such an option is not available throughout Canada.

[4] Wait-lists for clinical services, such as joint replacement surgery, are managed at the provincial and territorial levels. According to Masri *et al.* (2005), who studied the status of wait-time for JR procedures in Canada in order to understand the consequences of wait-times and potential solutions to problems of access, one of the most important aspects of wait-lists is its ability to prioritize patients to receive the awaited services. However, according to BCMA (2006), wait-lists in Canada are still evolving with various provincial initiatives currently underway to streamline prioritization criteria and establish acceptable wait-times.

[5] An agreement signed by the First Ministers to target improvement in priority healthcare areas over the next 10 years

The objective of this research is to test, across Canada, whether SES is correlated with: 1) timely access to JR procedures and, 2) post-operative outcomes of JR procedures.[6] I use wait-time for JR surgeries as a measure of timely-access and total length of stay at the hospital as a measure of outcome. My research is based on record-level de-identified data from 2005-2009 from CIHI's Discharge Abstract Database (DAD), which contains information on all hospital discharges across Canada, and the Canadian Joint Replacement Registry (CJRR), which contains information on joint replacement procedures performed in select hospitals in British Columbia, Alberta, Saskatchewan, Ontario, Nova Scotia, New Brunswick, and Newfoundland and Labrador. The two datasets were linked for a comprehensive, patient-level view on JR procedures in order to study the correlation of SES with wait-time and total length of stay.

I find that wait-time for elective JR procedures vary between those in the 'richest' income quintile and everyone else.[7] Patients belonging to the richest income quintile wait over 3% less (approximately 7 days) than all others. When wait-time was regressed on HR and KR separately, using the same control variables, the results were similar for HR, where patients in the highest income quintile waited 5.2% less than the lowest income quintile. However, this wasn't the case for KR, where no significant variation in wait-time was observed across all income quintiles. For females, those in the highest income quintile waited significantly less (3.2%) when compared to females in the lowest income quintile.

I also find that total length of stay varies by income. Patients in the highest income quintile experience 7% shorter hospital stays (approximately half a day) than those in the lowest income quintile. When HR

[6] As discussed in the Data section, the analysis in the paper is based on seven of the thirteen Provinces and Territories in Canada. However, the data are representative of the entire Canadian population. Therefore, the conclusions drawn from the results could be fully generalized at the pan-Canadian level.
[7] Given individual- or household-level income data were not available, Statistics Canada's income quintiles were used as a measure of socioeconomic status. The calculation of income quintiles is explained in the Methodology section.

and KR procedures were looked at separately, similar results were observed with the difference between lowest and the highest income quintiles of 5.6% and 8.2%, respectively. The total length of stay for females and males in highest income quintile was 6.8% and 7.3% less, respectively, than those in the lowest income quintile.[8]

The above evidence of relatively higher wait-time associated with higher SES highlights an important policy issue for both the healthcare providers and the government. It highlights the need for policy-makers and researchers to explore and understand the determinants of inequitable provision of access at the patient-level. Likewise, an increased likelihood of longer total length of stays for individuals with lower SES underpins the importance of understanding whether it is SES or other unobservable factors that are correlated with SES that lead to longer length of stays for patients with lower SES.

Section 2 provides a brief review of the existing literature on the correlation between SES and access to and outcome of JR procedures. Section 3 describes the data and Section 4 outlines the methodological framework for studying timely access and outcome areas. I present the results in Section 5, discuss them in Section 6 and make concluding remarks in Section 7.

2. Literature Review

Research on the correlation of SES with access to and outcomes of JR in the United States and Canada is in its nascent stage. Most of the research to date has been conducted in Europe and Australia.

[8] Wait-time was included as an independent variable when estimating the correlation between SES and total length of stay. This is not only intuitive, as longer waits could have an impact on a person's health leading to longer recovery time, it is also based on recommendations found in the literature (discussed in the Results section). To compare, I have also estimated the correlation between SES and total length of stay without using wait-time as a dependent (Appendix A). As expected, the coefficients on income quintiles remain statistically significant but become slightly smaller.

Additionally, most of the literature to date has focused on the issue of timely access (wait-time) to JR procedures only, likely because of its political relevance and implications related to system-level resource allocation.

The sections below summarize key findings, mostly from an international perspective, from research on access to and outcomes of JR procedures.

Timely Access to JR Procedures

Access to healthcare services is primarily examined through the lens of wait-time indicators. Excessive wait-time could have a significant impact on patients' quality of life and overall well-being. Additionally, waiting too long for a JR procedure has been shown to reduce the magnitude of improvement from surgery (Chesworth *et al.*, 2006 and Hajat *et al.*, 2002). According to Cipriano *et al.* (2007), several expert groups have recommended that patients should not wait longer than 6 months for JR surgery for the reasons cited above.

If there is a 'standard' threshold for JR wait-times, then it is not only interesting but also important to understand the following key factors that may affect that standard: system-level demand and the patient-level decision to go forward with a JR procedure. While the system-level demand for JR procedures is partly controlled by family physicians, it is also determined by factors such as population demographics, socioeconomic factors, increasing rates of obesity, shifting disease patterns, shifts in clinical criteria, presence and the willingness of patients to undergo surgery (Cipriano *et al.* 2007). The patient-level decision to go forward with a JR procedure, which has an impact on the overall number of surgeries at a given geographic level, depends on patient-level factors such as clinical characteristics of the hip, physician recommendations, patient's perceptions and preferences, and interactions between doctors and patients (Agabiti *et al.* 2007). Finally, ample international literature has clearly demonstrated that access to JR procedures is inequitable and varies by SES, gender, rurality, and ethnicity (Judge *et al.* 2010). The following sections provide further evidence on each of these variables as potential factors of inequity.

Socio-economic status

Many studies have shown lower socioeconomic status, or 'deprivation', to have direct negative association with access to JR procedures. By surveying a sample of individuals with moderate-to-severe hip/knee problems in Ontario, Canada, Hawker *et al.* (2002) studied the need for and willingness to undergo JR procedures and demonstrated that individuals with lower SES (and education) receive less arthritis care, including joint arthroplasty. According to Agabiti *et al.* (2007), who used hospital registry data for patients that underwent *elective* HR procedures between 1997 and 2000 in Italy, low-income people were less likely than high-income people to receive total hip replacement. On the contrary, studying fracture-related *urgent* joint replacement surgeries in Quebec, Hamilton *et al.* (1996) showed that patients from higher income postal-codes only experience slightly shorter delays, and that income has no substantial effect on post-surgery outcomes.

Gender

Using a cross-sectional population prevalence study based on self-completed survey, Milner *et al.* (2004) found that women in some health authorities in England were twice as likely to need hip replacement as men but are more likely to be managed by their GP or hospital consultant. Although it's hard to reason why access to JR procedures would vary by gender, Milner *et al.* (2004) also demonstrated that a greater proportion of men were on a wait-list than women. Similarly, Judge *et al.* (2010) found that compared with women, men received more provision for JR relative to individual need.

Rurality

Access to JR also varies according to geographic orientation. In the United Kingdom, rural inequalities in accessing health services are small. Studies in the USA and Northern Ireland found, however, that people in rural areas were more likely to receive HR than those in urban areas (Milner *et al.* 2004). Using a two stage, cross cohort approach to identify patients in need of hip/knee replacement, Judge *et al.* (2010) demonstrated that patients in urban areas got higher provision for KR relative to need, but for HR, the provision was highest in villages and isolated areas.[9]

Ethnicity:

International studies, mostly from the United States, have examined variation in JR procedures based on ethnicity and race. Dunlop *et al.* (2003) found that when compared with older black persons, older Hispanic persons had low rates of arthritis-related JR procedures even though the two groups had similar baseline needs. Katz *et al.* (1996) demonstrated that the odds of white persons receiving JR surgeries were more than 1.5 times greater than for black persons.

Outcomes of JR Procedures

In general, limited literature exists to date on the relationship between SES and outcomes of JR procedures.[10] Potential socioeconomic impact on adverse events after JR (particularly HR) procedure has not been studied in detail to date (Mahomed *et al.,* 2003). A couple of studies from Europe and the

[9] In the first stage, the authors used a small area population based survey to provide a high quality measure of need for hip/knee replacement. In the second stage, the authors used a nationally representative population based survey to identify patients in need of hip/knee replacement.

[10] More literature exists on access and outcomes related to emergency JR procedures. See Hamilton *et al.* (1996) and Hamilton *et al.* (2000). Both of these studies use Quebec hospital discharge data. Generally, contrary to one's intuition, these studies conclude that under emergency situation wait-time is not correlated with adverse post-surgery outcome.

United States show clear association between SES and outcomes of JR procedures. According to Agabiti *et al.* (2007), people with lower SES have higher probability of negative outcomes after JR procedure and that they are more vulnerable to acute adverse medical events post surgery. The effects were even higher among those aged 75+ years. Mahomed *et al.* (2003) studied outcomes within 90 days of JR procedures and found increased risk of death, readmission to hospital, and wound infections in low-income persons.

An important factor in understanding the relationship between SES and outcomes of JR procedure is the correlation between poorer access and poorer outcomes. For hip-fractures, Hamilton *et al.* (1996) and Hamilton *et al.* (2000) showed that the outcome measures are not correlated with wait-time for the surgery. However, for elective surgeries, Shortt (2000) documented that longer wait-time for medical services (including orthopaedic surgery) adversely affect patient quality of life, emotional well-being, morbidity and mortality.

It is clear from the above sections that timely access to and outcomes of JR procedures are key policy-relevant areas within the Canadian healthcare landscape. It is also clear that exploring and better understanding the potential relationship between SES and timely access to and outcomes of JR, at the pan-Canadian level, is imperative from a policy and decision-making perspective in the future.

3. Data

I use 2005-06 to 2009-10 data from the following two data sets from CIHI: Discharge Abstract Database and the Canadian Joint Replacement Registry.

Discharge Abstract Database[11]

The Discharge Abstract Database (DAD) contains demographic, administrative and clinical data for *all* hospital discharges (inpatient acute, chronic and rehabilitation) across Canada. Specifically, the DAD contains information on areas such as admission, discharge, diagnosis and intervention. CIHI receives DAD data directly from submitting facilities or from their respective regional or provincial ministries.

Canadian Joint Replacement Registry[12]

The Canadian Joint Replacement Registry (CJRR) captures record-level patient information on HR and KR replacement procedures performed in select hospitals in seven Canadian provinces: British Columbia, Alberta, Saskatchewan, Ontario, Nova Scotia, New Brunswick, and Newfoundland and Labrador. The CJRR is a voluntary registry that collects information directly from participating orthopedic surgeons.[13] The CJRR was developed to provide a rich set of additional patient, clinical and surgical information beyond what is captured in the DAD, allowing for more in-depth analysis of HR and KR procedures.

Given the difference in coverage between DAD and CJRR, not all records within the DAD had corresponding records within the CJRR. Since CJRR presents the 'lowest common denominator' and because wait-time information is only available in the CJRR, most of the analysis in this paper is based on 'linkable' records between the two data sets. It should be noted, however, that while the data in the study relate to the aforementioned seven provinces, they are representative of the entire Canadian

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[11] DAD and CJRR data have been widely used for peer-reviewed, discussion and policy papers. See De Guia *et al.* (2006), Bourne *et al.* (2007), Bourne *et al.* (2009), Hawker *et al.* (2006) and Hawker *et al.* (2009).

[12] CJRR data have been widely used for peer-reviewed, discussion and policy papers. See De Guia *et al.* (2006), Bourne *et al.* (2007) and Bourne *et al.* (2009).

[13] Voluntary submission happens when hospitals submit data without provincial or regional 'mandate' for submission to a particular entity (such as CIHI).

population. Therefore, the conclusions drawn from the results could be generalized at the pan-Canadian level.

Linkage between DAD and CJRR data sets

The possibility of linking DAD and CJRR presented a unique opportunity to study both wait-time and total length of stay, and how they correlated with SES for the same patient population. For DAD and CJRR each, CIHI provided five data files, each corresponding to a fiscal year between 2005 and 2009. For each year, the two data sets were merged using CIHI-provided 1) Project_id, a systematically generated unique but meaningless number provided in lieu of health care number and 2) Primary Intervention Date, which is considered the 'most responsible' intervention for patient's admission to the hospital. Subsequently, the merged records for each of the five years of data were appended to create a single 'final' dataset.

The following section explains the steps taken to prepare the 'final' dataset for analysis, as summarized in Figure 1.

Step 1: Of the 220,566 records in DAD from 2005-2009, 67,714 records had a corresponding match in the CJRR.[14] The remaining (152,852) records in the DAD didn't merge with the records in CJRR as the JR surgery wasn't captured as the Primary Intervention in the DAD.[15] Such situation may arise when a patient is admitted to a hospital for reasons other than JR procedures (such as appendectomy) but a need arises for the patient to undergo a joint replacement procedure while they are still at the hospital (for example, as a result of broken hip following a fall at the hospital). In this case, the JR would be

[14] Here, the number of records in DAD only relates to the seven provinces that submit to CJRR, and not to all of Canada.
[15] A discussion on the representativeness of a sample is available earlier in the Data section.

captured as a 'secondary' intervention. Given the focus of this paper, which is to study JR-related wait-time and length of stay, these non-merged records were excluded from the analysis.

Step 2 and 3: Given the objective of the study, it was imperative to only focus on non-emergent JR surgeries, those for which patients had to wait for specific time-periods for their turn, following which they were 'directly' admitted to the hospital on pre-determined surgery dates. Joint replacement procedures that were performed following accidents, for which patients are likely to be admitted through the hospital's emergency departments or as transfers from day-surgery and other such clinical settings, were excluded from the dataset.[16]

Step 4: Only those interventions representing HR and KR procedures were selected. The selection was based on the appropriate Canadian Classification of Health Interventions (CCI) codes within the Primary Intervention Code data element.[17]

Step 5: It was important to ensure that the records being analyzed only represented primary surgeries, i.e. those joint replacements that are performed for the first time. This step was performed to exclude any 'revision' procedures, which weren't of interest in this analysis.[18]

Step 6: Finally, only those records were kept for which wait-time information was available, approximately 60%. The missing wait-time information (in the remaining 40% of the records) is a data

[16] Hamilton et al. (1996) focused on fracture-related surgeries.

[17] The following CCI codes were used: 1.VA.53.** for implantation of internal device, hip joint for replacement of femoral and femoral with acetabulum, 1.SQ.53.** for implantation of internal device, pelvis for replacement of acetabulum alone, 1.VG.53.** for implantation of internal device, knee joint for replacement of patella with femoral and tibial surfaces and 1.VP.53.** for implantation of internal device, patella for replacement of patella alone.

[18] Revision procedures are performed to correct or replace a worn out joint replacement.

quality issue; the data submitters are not 'mandated' by CIHI to provide wait-time information for every single CJRR record.

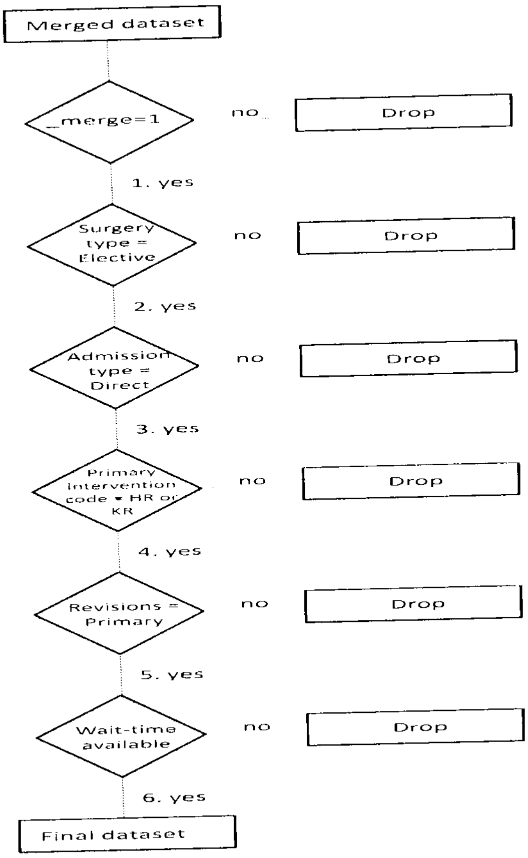

Figure 1: Steps taken to 'prepare' the final dataset for analytics.

4. Methodology

Key Variables

I use the following key variables to understand the correlation of SES with timely access to and outcomes of JR procedures:

Wait-time

Wait-time, a measure of access, is calculated as the difference between the following two variables available in the CJRR: 'date of decision for surgery' and 'surgery date'. The 'date of decision for surgery' refers to the date it was established that the patient needed the procedure. 'Surgery date' refers to the actual date when the procedure is performed.

Total length of stay

Total length of stay, which could be indicative of many 'adverse events' such as post-operative clinical complications and the need for 'specialized' care following discharge, refers to the duration (in days) for which the patient remains at the hospital. This includes Alternative Level of Care (ALC) stay. ALC refers to the care that is provided within hospital after the acute care need has already been met; in most cases, patients remain in ALC as they wait for suitable placement (rehab or convalescent care) following discharge to fully recover from the surgery.

Income quintile

Income quintile, a measure of socioeconomic status, is derived from Statistics Canada Census data by aggregating household income to the dissemination area and then ranking neighbourhoods by income quintile. This is done by measuring the mean household income of residents, ranking them from poorest to wealthiest, and then grouping them into 5 income quintiles (1 being poorest and 5 being wealthiest). Income quintiles, which were pre-constructed by Statistics Canada, are available for both urban and rural populations and, by definition, each quintile contains approximately 20% of the dissemination areas.

Income quintile is often used as a proxy measure of socio-economic status (Manitoba Centre for Health Policy, 2011) and Agabiti (2007). Given the unavailability of individual- or household-level income data, this study uses income quintiles. However, it is important to note that another measure of SES might yield different results. According to Geronimus and Bound (1998), attributing an aggregate-level indicator to the individual (or household) can underestimate the true association. Conclusions drawn from this study take this point into consideration.

Regression Equations

The correlation of SES with wait-time and total length of stay for JR procedures is estimated using the following regression equations.[19]

Wait-time

$$lWtim_{ijt} = \beta_0 + \sum_{y=1}^{5} \beta_{1y} Inc_i + \beta_2 Urban_j + \beta_3 Como_i + \beta_4 Como_i^2 + \beta_5 Overweight_i + \beta_6 Obese_i + \beta_7 Male_i + \beta_8 Age_i + \beta_9 Age_i^2 + \beta_{10} Dist_i + \beta_{11} Dist_i^2 + \sum_{y=1}^{7} \beta_{12y} \mathrm{Prov}_j + \sum_{y=1}^{5} \beta_{13y} Year_t + \mu_{ijt}$$

Total length of stay

$$lTlos_{ijt} = \beta_0 + \sum_{y=1}^{5} \beta_{1y} Inc_i + \beta_2 Wtim_i + \beta_3 Urban_j + \beta_4 Como_i + \beta_5 Como_i^2 + \beta_6 Disp_i + \beta_7 Male_i + \beta_8 Age_i + \beta_9 Age_i^2 + \beta_{10} Dist_i + \beta_{11} Dist_i^2 + \beta_{12} Overweight_i + \beta_{13} Obese_i + \sum_{y=1}^{7} \beta_{14y} \mathrm{Prov}_j + \sum_{y=1}^{5} \beta_{15y} Year_t + \mu_{ijt}$$

[19] Using robust standard errors

where i being individuals, j being the provinces and t being the time. *lWTim* represents log of wait-time for the primary replacement procedures; *lTloS* is the log of total length of stay at hospital for a JR procedure; Inc represents binary variables for the income quintiles; *Urban* is an indicator for urban versus rural residence of the patient; *Como* is the number of co-morbid conditions documented during hospital stay; *Overweight* represents those patients whose body mass index (BMI) was between 25 and 29.9; *Obese* represents those patients whose BMI was equal to or greater than 30; *Male* an indicator for gender; *Age* is age in years at admission and will be used to understand age-related variation; *Dist* is the 'as the crow flies' distance between the patients' postal code and the hospital where the surgery is performed; *Prov* is the province dummy in which the hospital is located; *Disp* is the non-home bound discharges following JR procedure; *Year* is the year dummy, and μ is the error term.[20][21]

All regressions are estimated with OLS and robust standard errors are reported in the below tables.

5. Results

Key Patient Population Characteristics

Given the difference in coverage between DAD and CJRR, as mentioned in the Data section, it was important to compare basic patient population-level characteristics of linkable and non-linkable records for potential similarities and differences to speak to the representativeness of the sample.[22] Table 1

[20] BMI is a general measure of obesity as weight (in kilograms) divided by the square of height (in metres). Some national and international literature – Statistics Canada (2011), World Health Organization (1995) and Goel *et al.* (1996) - has categorized BMI as follows: less than 18.5 (underweight); 18.5 to 24.9 (normal weight); 25.0 to 29.9 (overweight); 30.0 to 34.9 (obese, class I); 35.0 to 39.9 (obese, class II); 40.0 and higher (obese, class III). Given that overweight and obesity are likely to influence both wait-time and total length of stay, this paper focused on BMIs equal to or greater than 25 (i.e. overweight and obese categories).

[21] Distance was used in addition to using urban/rural classification in order to explore whether absolute distance makes a difference when studying wait-time and total length of stay for JR procedures.

[22] Recall that DAD contains records for all JR procedures in Canada whereas CJRR only represents seven Provinces.

compares key patient population-level characteristics for the following: linked records with wait-time information (final dataset), linked records with no wait-time information and non-linked records.

As observed in Table 1, the DAD contained 220,566 JR discharge records between 2005 and 2009. Of these, approximately 67,714 (35%) had corresponding records in CJRR. Of the CJRR records that linked with the DAD, 40,509 (60%) had wait-time information.

Except for a slight difference observed for percentage of patient population residing in urban setting, it seems from Table 1 that the patient characteristics for the three 'population-types', in terms of averages, are similar.

Table 1: Comparison of key characteristics of the patient population between the linked and non-linked records in DAD and CJRR:

Key characteristics	**DAD records linked to CJRR**		**DAD records not linked to CJRR**
	With wait-time	**Without wait-time**	
(1)	**(2)**	**(3)**	**(4)**
Wait-time (days)	204	-	-
Length of Stay (days)	5.0	4.9	4.6
Age (year)	66.7	66.7	67.5
% female	58.2	58.9	58.9
Income			
% quintile 1	18.3	17.8	18.3
% quintile 2	20.3	19.5	20.2
% quintile 3	20.2	21.0	20.8
% quintile 4	20.5	20.7	20.1
% quintile 5	20.7	21.0	20.6
Avg. no. of co-morbidities	3.3	3.5	3.3
% urban	69.0	70.6	73.4
Avg. distance from hospital	54.4	55.3	42.6
Median BMI	30	30*	-
Observations	40509	27205	152852

a. * Based on 18143 observations as BMI was not assigned to all of the 27205 records
b. Provinces and Territories not submitting to the CJRR are not represented in the stats shown in column 4.

The average wait-time for joint replacement surgery in select Canadian provinces is approximately 204 days (or 29 weeks). When admitted to hospital, these patients have a median BMI of approximately 30 (just the middle point between overweight and obesity as defined above) and just over 3 co-morbid conditions on average. Most of these patients, approximately 70%, reside in urban areas. The average age of the patients is close to 67 and approximately 58% of these patients are female. The patient population receiving joint replacement procedures is almost evenly distributed across the income quintiles, with the lowest income quintile having the lowest number of patient population (18.3%).

I also performed the Kolmorov-Smirnov test to explore the statistical significance of the differences found in Table 1 between those merged records that did and didn't have wait-time information available. The test was performed for total length of stay, distance to hospital, BMI and age. The results (p-value 0.0000) for the first three variables indicate that the two 'groups' (i.e. patients for whom wait-time was and wasn't recorded) do not come from the same distribution. However, the result (p-value 0.607) for the age variable indicates that the two 'groups' do have the same distribution. These findings present a future opportunity to further explore the data so as to establish why these results are being observed and what the implications might be on the representativeness of the final sample. Not having the hospital-level characteristics available for this study limited my ability to undertake this exploratory work.

Distribution of wait-time and total length of stay by income

Figure 1 and 2 are Kernel Density plots presented to demonstrate potential differences in terms of wait-time and total length of stay for the lowest and highest income quintiles.

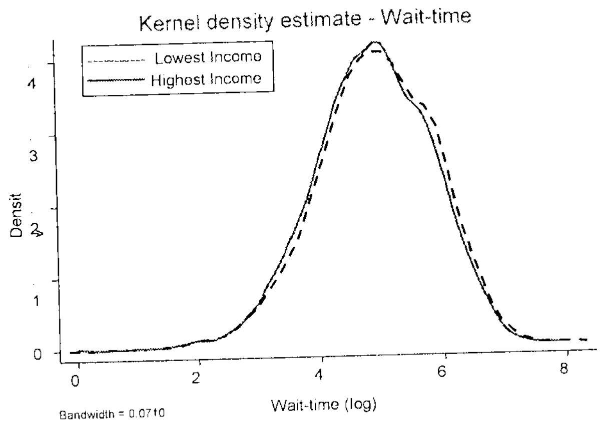

Figure 2: Wait-time Kernel Density plot for income quintiles 1 and 5

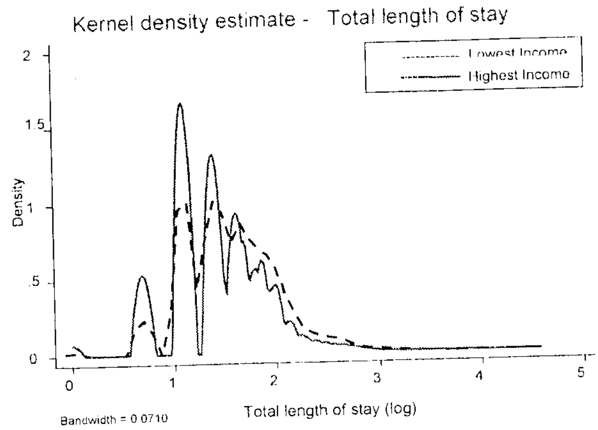

Figure 3: Total length of stay Kernel Density plot for income quintiles 1 and 5

The Kernel Density plots reveal a slight difference in wait-time and total length of stay based for patients in lowest and highest income quintiles. In both cases, patients relating to highest socioeconomic status are relatively better off than those relating to the lowest socioeconomic status. In other words, richer people wait-less for their surgery and fare better following the surgery in terms of a quicker discharge from the hospital.

The results from the Komorov-Smirnov test for each of the above plots (p-value 0.0000) lead to the rejection of the null hypothesis that the two 'groups' (lowest income quintile and highest income quintile) come from a common distribution. These findings are intuitive as the results shown in the subsequent sections (see Table 3 and 4) demonstrate statistically significant differences between the poorest and the richest in terms of wait-time and total length of stay.

Correlation between wait-time and total length of stay

Recall from an earlier section (Literature Review) that an important factor in understanding the relationship between SES and outcomes of JR procedure is the correlation between delayed access (longer wait-time) and poorer outcome (total length of stay). This was explored, as presented in Table 2, by studying total length of stay for JR procedures according to the following four categories of surgery wait-times: one month or less, 2) between one and three months, 3) between three and six months, and 4) more than 6 months.

According to Table 2, the mean and median length of stay seems stable across all four categories of wait-time, with a slight increase observed for the longest wait-time category. This observation supports the aforementioned recommendation that patients waiting for joint replacement surgery should not wait for longer than six months. As observed in Table 2, patients that wait for more than six months to receive joint replacement surgery end up with staying longer in the hospital before being discharged. The average number of co-morbid conditions doesn't vary by surgical wait-times.

Table 2: Relationship between wait-time for all JR surgeries and mean and median total length of stay at the hospital

Wait time (1)	N (2)	% (3)	Co-morbidities (4)	Mean LoS (5)	Median LoS (6)
0-1 month	2797	6.9	3.3	4.9	4
1-3 months	10669	26.3	3.3	4.7	4
3-6 months	11243	27.8	3.4	4.9	4
>6 months	15800	39	3.3	5.2	5

Correlation between SES and wait-time

Table 3 presents the results of regressing log wait-time on income quintiles and other key variables for all JR surgeries (i.e., HR and KR combined). Additionally, similar regressions were run separately for HR procedures and KR procedures to explore variation in terms of joint-type. Gender-related variations were also explored through similar regressions.

Table 3: Correlation between SES and wait-time for JR surgeries

Variables Dep var: Wait-time (log)	All Joint Replacements		Joint Type				Gender			
			Hip		Knee		Female		Male	
Income Quintile										
2nd	0.013	(0.014)	-0.009	(0.023)	0.029	(0.018)	0.016	(0.018)	0.011	(0.023)
3rd	-0.009	(0.014)	-0.013	(0.023)	-0.002	(0.018)	-0.009	(0.018)	-0.006	(0.023)
4th	0.008	(0.014)	-0.008	(0.023)	0.024	(0.018)	0.002	(0.019)	0.016	(0.023)
5th	-0.031**	(0.014)	-0.052**	(0.023)	-0.006	(0.018)	-0.032*	(0.019)	-0.029	(0.022)
Urban	-0.025*	(0.014)	-0.012	(0.022)	-0.041**	(0.018)	-0.012	(0.019)	-0.041*	(0.022)
Urban/Rural Unknown	0.007	(0.017)	0.023	(0.027)	-0.003	(0.022)	0.008	(0.023)	0.005	(0.026)
Co-morbidities	0.005	(0.008)	-0.012	(0.012)	0.020+	(0.010)	-0.001	(0.011)	0.012	(0.012)
Co-morbidities^2	0.000	(0.001)	0.001	(0.001)	-0.001	(0.001)	0.000	(0.001)	-0.001	(0.001)
Overweight	0.039**	(0.015)	0.019	(0.021)	0.017	(0.022)	0.057***	(0.019)	0.012	(0.025)
Obese	0.126***	(0.015)	0.047**	(0.021)	0.087***	(0.021)	0.147***	(0.018)	0.091***	(0.025)
BMI Missing	0.111***	(0.017)	0.060**	(0.024)	0.082***	(0.023)	0.107***	(0.021)	0.113***	(0.027)
Male	0.012	(0.009)	0.046***	(0.014)	0.005	(0.012)	0.000	(0.000)	0.000	(0.000)
Age	0.036***	(0.004)	0.023***	(0.005)	0.039***	(0.006)	0.038***	(0.005)	0.032***	(0.005)
Age^2	-0.000***	(0.000)	-0.000***	(0.000)	-0.000***	(0.000)	-0.000***	(0.000)	-0.000***	(0.000)
Distance to Hospital	-0.000**	(0.000)	-0.001***	(0.000)	0.000	(0.000)	-0.000+	(0.000)	0.000	(0.000)
Distance to Hospital^2	0.000	(0.000)	0.000***	(0.000)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)
Provincial Variation										
NL	0.174***	(0.034)	0.097*	(0.059)	0.215***	(0.041)	0.185***	(0.044)	0.150***	(0.052)
NS	1.032***	(0.021)	0.946***	(0.036)	1.080***	(0.025)	1.065***	(0.027)	0.978***	(0.033)
NB	0.518***	(0.020)	0.527***	(0.032)	0.520***	(0.026)	0.530***	(0.026)	0.495***	(0.032)
SK	1.232***	(0.019)	1.065***	(0.035)	1.311***	(0.022)	1.238***	(0.025)	1.217***	(0.030)
AB	0.455***	(0.015)	0.296***	(0.025)	0.545***	(0.019)	0.493***	(0.020)	0.396***	(0.025)
BC	0.461***	(0.014)	0.420***	(0.023)	0.505***	(0.018)	0.486***	(0.018)	0.419***	(0.023)
Time Variation										
2006	-0.119***	(0.016)	-0.118***	(0.025)	-0.120***	(0.020)	-0.105***	(0.021)	-0.137***	(0.024)
2007	-0.223***	(0.016)	-0.281***	(0.025)	-0.186***	(0.020)	-0.186***	(0.021)	-0.273***	(0.024)
2008	-0.271***	(0.015)	-0.299***	(0.024)	-0.256***	(0.019)	-0.224***	(0.020)	-0.335***	(0.023)
2009	-0.394***	(0.015)	-0.419***	(0.023)	-0.381***	(0.019)	-0.350***	(0.020)	-0.454***	(0.023)
Constant	3.397***	(0.117)	3.915***	(0.147)	3.305***	(0.211)	3.288***	(0.158)	3.606***	(0.176)
Observations	40509		16155		24354		23567		16942	

a. Robust standard errors in parentheses
b. * significant at 10%; ** significant at 5%; *** significant at 1%

The lowest quintile was used as a reference for income-quintile binary variables. For urban/rural binary variables, rural residence was used as a reference. Records without urban/rural assignment were captured as 'Urban/Rural Unknown'. It was important to take these records into consideration in order to explore whether they differed from those for which rurality was flagged. Similarly, not all patient-records had BMI value assigned to them. These records were categorized under 'BMI Missing' variable, which was included in the regression.

For all JR, no significant differences were observed in wait-time between income quintiles 1 and 2-4. However, the wait-time was significantly different for the 5th income quintile. Those patients belonging to the highest income quintile waited 3.1% less time (approximately one week) to receive a JR surgery than those in the lowest income quintile, everything else being equal. When wait-time was regressed on HR and KR separately, using the same control variables, the results were similar for HR, where the patients in the highest income quintile waited 5.2% less than the lowest income quintile. However, this wasn't the case for KR, where no significant variation in wait-time was observed across all income quintiles. For females, those in the highest income quintile waited significantly less (3.2%) when compared to females in the lowest income quintile.

The coefficients for Urban were only significant for all JR procedures, KR procedures and males. For all JR procedures and KR procedures, patients residing in urban setting tend to wait 2.5% and 4.1% less than those residing in rural settings, respectively. Males residing in rural settings waited for 4.1% less time than their rural counterparts to undergo a JR surgery. Results indicate that residing in urban centres matters, albeit slightly, when it comes to waiting for KR procedures and not so much for HR procedures. Also, gender matters in terms of wait-time for JR procedures based on urban and rural residence. The coefficients on comorbidity-related variables are not significant and also indicate that comorbidity is linear.

The coefficients for Overweight and Obese variables clearly indicate a correlation between patients' BMI and the amount of time they wait for JR surgeries. For all JR procedures, a 1 kilogram increase in patients' weight translated into 3.9% and 12.6% longer wait within the Overweight and Obese categories, respectively. The coefficients for the Obese category were also significant when wait-time was regressed separately HR procedures, KR procedures, females and males. The results for the BMI Missing category were similar to those of the obese patients. The coefficient for gender was only significant for HR procedures indicating that males tend to wait 4.6% more than females to receive an HR surgery. However, gender did not matter for all JR and KR procedures. Coefficients on Age and Age^2 indicate a non-linear relationship between age and wait-time such that wait-time increases but at a decreasing rate with patients' age. How far a patient lives from the hospital has a linear but negligible correlation with his/her wait-time. However the coefficients of Distance to Hospital variables are negative and imply that patients living relatively farther receive their surgery relatively quicker. Finally, all coefficients on year dummies are significant and negative indicating that the wait-time for JR between 2005 and 2009 reduced by approximately 39% for the provinces included in the analysis.

Correlation between SES and total length of stay

An approach similar to the above was used to understand the correlation between SES and the total length of stay. However, wait-time was also included in the regression as an independent variable to control for its potential on post-surgical outcome.[23] Although Table 4 shows that the wait-time coefficients were negligible, they do show a significant and positive correlation with length of stay implying that longer wait-times could potentially lead to marginally longer total length of stay for JR procedures. Additionally, non-home bound discharges were also controlled for in the regression as

[23] Shortt (2000) documented that longer wait-time for medical services (including orthopaedic surgery) adversely affect patient quality of life, emotional well-being, morbidity and mortality. Additionally, Table 3 also shows wait-time being lower for patients in the highest income quintile.

patients who are discharged to settings other than home may stay longer at the hospital as they await suitable placement.

Income has a very clear correlation with total length of stay for JR procedures. For all JR procedures, income is negatively and significantly correlated with the total length of stay. The total length of stay continuously decreases from lowest to highest income quintiles, with the coefficient on the highest income quintile indicating a 7.1% (approximately half a day) reduction in hospital stay as compared to the lowest income quintile. When HR and KR procedures were looked at separately, similar results were observed with the difference between lowest and the highest income quintiles of 5.6% and 8.2%, respectively. The total length of stay for females and males in highest income quintile was 6.8% and 7.3% less than those in the lowest income quintile, respectively. The results shown in Appendix A are based on a similar regression but without having wait-time as a dependant variable. As expected, the coefficients on income quintiles remain statistically significant but become slightly smaller than those in Table 4.

For total length of stay, relative proximity to the hospital also matters as indicated by coefficients for Urban and Distance to Hospital. Comparatively, whether a patients live in urban vs. rural settings matters more than the absolute distance between a patients' residence and hospital. For all JR procedures, patients living in urban centres spend 2.6% less time in the hospital. Similarly, for HR procedures, those living in urban settings have total length of stay that is 3.7% shorter than those living in rural areas. Males living in urban areas spend 3.5% less time than males living in rural settings for JR procedures.

Table 4: Correlation between SES and total length of stay for JR surgeries

ariables Dep var: Total length of stay (log)	All Joint Replacements		Joint Type: Hip		Joint Type: Knee		Gender: Female		Gender: Male	
Income Quintile										
2nd	-0.024***	(0.006)	-0.011	(0.010)	-0.030***	(0.008)	-0.029***	(0.008)	-0.015	(0.010)
3rd	-0.038***	(0.006)	-0.036***	(0.010)	-0.039***	(0.008)	-0.037***	(0.008)	-0.038***	(0.010)
4th	-0.044***	(0.006)	-0.033***	(0.010)	-0.052***	(0.008)	-0.048***	(0.008)	-0.037***	(0.010)
5th	-0.071***	(0.006)	-0.056***	(0.010)	-0.082***	(0.008)	-0.068***	(0.008)	-0.073***	(0.010)
Wait-time	0.000***	(0.000)	0.000***	(0.000)	0.000***	(0.000)	0.000***	(0.000)	0.000***	(0.000)
Urban	0.026***	(0.006)	0.037***	(0.009)	0.015**	(0.008)	0.020**	(0.008)	0.035***	(0.009)
Urban/Rural Unknown	0.008	(0.007)	0.030***	(0.011)	-0.006	(0.009)	0.005	(0.009)	0.011	(0.011)
Co-morbidities	0.048***	(0.004)	0.050***	(0.006)	0.047***	(0.006)	0.049***	(0.006)	0.052***	(0.008)
Co-morbidities^2	0.001*	(0.000)	0.000	(0.001)	0.001**	(0.001)	0.000	(0.001)	0.001	(0.001)
Non-home Discharges	0.079***	(0.005)	0.094***	(0.008)	0.063***	(0.006)	0.077***	(0.006)	0.082***	(0.008)
Male	-0.080***	(0.004)	-0.091***	(0.006)	-0.071***	(0.005)	0.000	(0.000)	0.000	(0.000)
Age	-0.023***	(0.002)	-0.019***	(0.002)	-0.036***	(0.003)	-0.024***	(0.002)	-0.022***	(0.002)
Age^2	0.000***	(0.000)	0.000***	(0.000)	0.000***	(0.000)	0.000***	(0.000)	0.000***	(0.000)
Distance to Hospital	-0.000***	(0.000)	-0.000***	(0.000)	-0.000***	(0.000)	-0.000***	(0.000)	0.000	(0.000)
Distance to Hospital^2	0.000***	(0.000)	0.000***	(0.000)	0.000***	(0.000)	0.000***	(0.000)	0.000	(0.000)
Overweight	-0.008	(0.007)	0.003	(0.009)	-0.009	(0.010)	0.001	(0.009)	-0.014	(0.011)
Obese	0.030***	(0.006)	0.047***	(0.009)	0.030***	(0.010)	0.037***	(0.008)	0.022**	(0.011)
MI-missing	0.022***	(0.007)	0.020**	(0.010)	0.031***	(0.010)	0.009	(0.009)	0.044***	(0.012)
Provincial Variation										
NL	0.489***	(0.013)	0.485***	(0.022)	0.492***	(0.016)	0.504***	(0.017)	0.460***	(0.021)
NS	0.251***	(0.010)	0.294***	(0.015)	0.218***	(0.012)	0.270***	(0.012)	0.219***	(0.015)
NB	0.443***	(0.008)	0.441***	(0.013)	0.437***	(0.010)	0.450***	(0.010)	0.427***	(0.013)
SK	0.360***	(0.010)	0.315***	(0.016)	0.379*	(0.012)	0.376***	(0.012)	0.334***	(0.015)
AB	0.029***	(0.008)	0.030**	(0.013)	0.024**	(0.010)	0.052***	(0.010)	-0.01	(0.013)
BC	0.004	(0.007)	0.015	(0.012)	-0.011	(0.009)	0.027***	(0.009)	-0.034***	(0.012)
Time Variation										
2006	-0.089***	(0.007)	-0.103***	(0.010)	-0.079***	(0.009)	-0.069***	(0.008)	-0.117***	(0.011)
2007	-0.149***	(0.007)	-0.172***	(0.010)	-0.133***	(0.009)	-0.131***	(0.008)	-0.173***	(0.011)
2008	-0.175***	(0.006)	-0.194***	(0.010)	-0.161***	(0.009)	-0.155***	(0.008)	-0.201***	(0.010)
2009	-0.200***	(0.006)	-0.214***	(0.010)	-0.190***	(0.008)	-0.185***	(0.008)	-0.220***	(0.010)
Constant	1.739***	(0.053)	1.569***	(0.064)	2.221***	(0.094)	1.794***	(0.073)	1.629***	(0.077)
Observations	40509		16155		24354		23567		16942	

a. Robust standard errors in parentheses
b. * significant at 10%; ** significant at 5%; *** significant at 1%

The effect of co-morbidities on total length of stay is non-linear for all JRs. The coefficients on comorbidity-related variables for all JR procedures are significant and indicate that as the number of co-morbid conditions increases, the total length of stay increases at an increasing rate. For all JR procedures, the total length of stay for males is 8% shorter than those of females. Similar results are observed when HR and KR procedures are looked at separately. The overall effect on Age is positive and significant, implying that older patients face longer length-of stay.[24] While being overweight doesn't make a statistically significant difference on total length of stay, being obese does. For all JR procedures, obese patients spend 3% more time in the hospital. Obese females spend 3.7% more times in hospital for all JR procedures than non-obese females. Finally, another interesting observation is that the total length of stay for all JR procedures has reduced by approximately 20% between 2005 and 2009 the provinces included in the analysis.

6. Discussion

The following sections present a discussion on the results observed above:

Wait-time for JR procedures

Socioeconomic Status

The results indicate that wait-time for JR procedures vary between those in the 'richest' income quintile and everyone else. Similar estimates were obtained (3.4%) for the highest income quintile when tested against the first four quintiles jointly. Although patients in the richest income quintile only wait a week less than all others, it should be noted that approximately 40% of the patients waiting to receive a JR surgery belong to the richest income quintile. A week of difference in wait-time may not seem

[24] While the coefficients on Age^2 are negligible, estimating the derivative of total length of stay over the derivative of age shows age as having a positive correlation with total length of stay.

substantial at a patient-level, but it could have a significant impact at the aggregate, health system-level for individuals belonging to the first four quintiles.

There are a couple of additional factors to consider when looking at the observed results: 1) Wait-lists in Canada are still evolving with various provincial initiatives currently underway to streamline prioritization criteria and establish acceptable wait-time (BCMA, 2006), 2) As mentioned above, a more granular measure of SES (such as household- or individual-level income) may yield different results.

Proximity to hospital

Acute care hospitals, where JR surgeries take place, are located within or close to the urban centres across Canada. However, patients living in urban centres, meaning closer to the hospitals, fare only marginally better in terms of wait-time. Examining both the urban/rual variables as well as the distance-related variables, it seems that the absolute distance between a patient's residence and hospital doesn't matter as much as residing in the urban centres.

Co-morbidities

The number of co-morbidities did matter in terms for wait-time for Hamilton et al. (1996), where the authors studied 'urgent' JR surgeries as result of fractures. In this paper, the results indicate that the number of co-morbidities doesn't seem to matter too much. One explanation is that for elective surgeries, where patients wait approximately 6.5 months on average for their turn as opposed to a few days following fractures, they are in more 'stabilized' conditions as a result of their ongoing interaction with and management by their family physicians. In other words, these patients have better, more stabilized baseline conditions going in to the surgery. It is important to note that the above analysis only takes into consideration the *number* of co-morbidities. From a clinical perspective, diseases vary in terms of their interacting effects. Separating clinically 'complex' diseases from 'benign' chronic diseases and re-conducting the above analysis may yield different results than those observed here. In a US-based study, certain chronic diseases were shown to be correlated with increased postoperative complications and non-homebound discharges in patients undergoing JR surgeries (Jain *et al.*, 2005).

Hamilton *et al.* (1996) documented the endogeniety of co-morbidity in that it influences both access to and outcomes of JR procedures. Specifically, a physician could decide to delay a JR procedure due to co-morbid conditions, and multiple co-morbid conditions could also impact the overall recovery from the JR procedure potentially resulting in a revision procedure. This situation could also apply to obesity. While this would be a methodological issue for 'urgent' JR surgeries following fractures, which Hamilton *et al.* (1996) studied, it doesn't have the same effect on elective surgeries. As mentioned above, for elective surgeries, while the patients wait for their turn they are continuously managed by their family physicians. As a result, patients that receive elective surgery, on a pre-determined date, are clinically more stable than those receiving urgent surgeries.

Obesity

The results indicate that obesity has a definite correlation with how long patients wait for JR surgeries, whether they are undergoing HR procedure, KR procedure or whether they are male or female. These findings align well with what other researchers have found. There are at least two ways of looking at joint replacement vis-à-vis obesity. First of all, one of the reasons why people need JR is because their hip and knee joints have been worn out due to their excessive weights. Secondly, obese patients also run a higher risk of adverse outcome in terms of recovering from joint replacement surgeries. From a clinical perspective, taking patients' weight into account is an important consideration in terms of the right timing for JR surgeries; physicians balance the urgency of replacing obese patients' worn-out joints from excessive weight against 'stabilizing' their weight for better post-surgical outcomes.

Aging

The above results indicate that age also matters, albeit marginally, in terms of wait-time. Wait-time increases with age but at a decreasing rate. These results could be interpreted the same way as the preceding two variables (co-morbidities and obesity). Since higher age implies higher number of chronic co-morbid conditions, it is clinically important to stabilize the patients prior to the surgery for better post-surgical outcomes, which may add to their wait-time. Physicians' clinical judgment serves as an overlay on the surgery-services that are 'rationed' by centralized wait-lists and, hence, variables such as age and obesity matter in terms of how soon a patient is able to access JR procedures.

Total length of stay for JR procedure

Socioeconomic Status

The observation, as per Table 4, that length of stay for all JR procedure is shortest for patients in the highest income quintile is intuitive. People that are socio-economically better-off enjoy better quality of life in terms of health, support-systems, etc. They go in to the surgery with better baseline health status, which has a positive impact on their chances of recovering faster than those in the lower income quintiles. These patients may then also be discharged earlier from the hospitals as they have resources to fare better at home following the surgery. From a system-level perspective, shorter length of stay helps alleviate issues related to wait-time and bed shortage for new patients.

Proximity to hospital

While the correlation of absolute distance with a patient's residence and the operating hospital is almost negligible on patient's total length of stay for a JR procedure, whether a patient lives in urban vs. rural area does matter. This is likely because of the fact that most, if not all, of the urgent care facilities in Canada are located within or in close proximity of large urban centres. Everything else being equal, patients residing in urban centres could be discharged out of the hospital to home or other clinical facility for full post-operative recovery. However, since patients residing in rural areas don't have as much access to alternative clinical facilities in rural settings, and because they would need to travel long distance should they require follow-up care, they end up spending relatively more time at the operating hospital until they are 'fully' recovered.

Co-morbidities

Multiple pre-operative chronic conditions, or acute conditions developed during the hospital stay, could have an adverse impact on the total length of stay for JR procedures. These co-morbid conditions add to the 'clinical complexity' of patient's recovery from the JR procedures and, hence, these patients end up staying longer at the hospital.

Obesity

The explanation for why obesity has a significant correlation with total length of stay for JR procedures is similar to the above section (Co-morbidities). Being obese puts extra strain on the recovering joints and, hence, obese patients require longer care at the hospital before they are discharged. According to Jain *et al.* (2005), obese patients are 1.3 times more likely to have a complication after JR procedure as compared with patients who were not obese.

Aging

The results suggest that the total length of stay increases with age. This result is also intuitive as, generally speaking, older people are frail and have multiple chronic conditions having an impact on their recovery time at the hospital before being discharged.

7. Conclusion

This research presented a unique opportunity to explore the correlation between socioeconomic status and key access and outcome variables for JR in 7 of the 13 Canadian provinces and territories. The observed results align well with what's been observed in Europe and Australia, where the healthcare system is similar to that of Canada. For elective JR procedures, lower wait-time is clearly observed between those in the richest income quintile and those in the remaining quintiles. However, a 'gradual' difference in wait-time is not observed across all income quintiles, which might have been different if individual-level income information was available. In any case, these findings could have meaningful policy implications. For example, limited disparity in wait-time based on income status, as observed in the study, could be reassuring to the Canadian public as well as policy makers. It may suggest that the Canadian system is relatively more equitable than some of the European countries and Australia, in providing access to an important clinical service such as joint replacement. At the same time, it raises questions as to why the richest still enjoy relatively shorter wait-times despite the clear provision of equal access in the Canada Health Act. It would be worthwhile to conduct a similar analysis for the remaining 6 provinces and territories to explore whether the observed wait-time results relate to all of Canada. Future research could also attempt to understand the impact, on the above results, of higher-income Canadians availing JR surgeries from US-based private institutions.

Total length of stay does vary continuously across all income quintiles with patients in the richest quintile facing the shortest length of stay. This too could have meaningful policy implications. The concept of income-redistribution may seem as a plausible policy tool to address the disparity between how well patients fare post-JR (and likely other types of) surgeries. However, such policy tool requires a longer-term commitment from the Canadian policy-makers to the Canadian public as achieving the ultimate goal of improved quality of life for the 'marginalized' is a longer-term process. It should also be noted that income may be correlated with an unobserved variable deriving the observed results. In this case, income redistribution won't help eliminate disparity in outcome from JR procedures. The above results provide an incentive to better understand why income matters in terms of length of stay.

It should also be noted that this study is only based on a 'quantitative' measure of outcome (total length of stay), and not qualitative factors such as patients' quality of life. Future efforts to understand outcome on a more comprehensive basis should take both quantitative and qualitative measures of outcome into account.

As cited above, it was interesting to observe that both wait-time and total length of stay for JR procedures have decreased significantly between 2005 and 2009. This must be reassuring to the healthcare policy- and decision-makers given their commitment and concerted efforts to reduce both wait-time and in-hospital stay as part of the 2004 Health Care Accord. This is also an important finding to feed into the upcoming discussions on the renewal of the current Health Care Accord which expires in 2014.

Finally, taking hospital-related characteristics into account was important for the planned analysis and subsequent interpretation of results. Unfortunately, these were not available for inclusion in the study.

Having data on hospital-related characteristics, such as location and size (in terms of number of beds), in the future could provide further insight in understanding the timely access and outcome areas for joint replacement.

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Appendix A

The effect of SES on total length of stay for JR surgeries (without wait-time as a dependent variable)

Variables Dep var: Total length of stay (log)	All Joint Replacements		Joint Type				Gender			
			Hip		Knee		Female		Male	
Income Quintile										
2nd	-0.026***	(0.005)	-0.028***	(0.008)	-0.024***	(0.006)	-0.028***	(0.006)	-0.021***	(0.008)
3rd	-0.036***	(0.005)	-0.047***	(0.008)	-0.030***	(0.006)	-0.030***	(0.006)	-0.044***	(0.008)
4th	-0.041***	(0.005)	-0.037***	(0.008)	-0.045***	(0.006)	-0.039***	(0.006)	-0.044***	(0.008)
5th	-0.066***	(0.005)	-0.060***	(0.008)	-0.071***	(0.006)	-0.061***	(0.006)	-0.071***	(0.008)
Urban	0.023***	(0.005)	0.036***	(0.007)	0.014**	(0.006)	0.013**	(0.006)	0.034***	(0.007)
Urban/Rural Unknown	0.004	(0.005)	0.023***	(0.009)	-0.007	(0.007)	0.001	(0.007)	0.008	(0.008)
Co-morbidities	0.052***	(0.003)	0.050***	(0.005)	0.053***	(0.005)	0.054***	(0.004)	0.053***	(0.006)
Co-morbidities^2	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)	0.001+	(0.001)
Non-home Discharges	0.065***	(0.004)	0.076***	(0.006)	0.054***	(0.005)	0.060***	(0.005)	0.075***	(0.006)
Male	-0.079***	(0.003)	-0.084***	(0.005)	-0.075***	(0.004)	0.000	(0.000)	0.000	(0.000)
Age	-0.024***	(0.001)	-0.023***	(0.002)	-0.033***	(0.002)	-0.025***	(0.002)	-0.023***	(0.002)
Age^2	0.000***	(0.000)	0.000***	0.000	0.000***	0.000	0.000***	(0.000)	0.000***	0.000
	0.000	(0.000)	0.000	0.000	0.000	-0.000*	0.000	(0.000)	0.000	(0.000)
Distance to Hospital	-0.000***	(0.000)	0.000	0.000	-0.000***	0.000	-0.000***	(0.000)	0.000**	(0.000)
Distance to Hospital^2	0.000***	(0.000)	0.000	0.000	0.000***	0.000	0.000***	(0.000)	0.000	(0.000)
Overweight	-0.005	(0.006)	0.003	(0.007)	-0.003	(0.008)	-0.002	(0.007)	-0.006	(0.009)
Obese	0.028***	(0.005)	0.044***	(0.007)	0.032***	(0.008)	0.034***	(0.006)	0.020**	(0.009)
BMI-missing	0.038***	(0.006)	0.033***	(0.008)	0.051***	(0.008)	0.027***	(0.007)	0.056***	(0.010)
Provincial Variation										
NL	0.485***	(0.011)	0.456***	(0.018)	0.502***	(0.013)	0.502***	(0.014)	0.456***	(0.017)
NS	0.237***	(0.007)	0.227***	(0.011)	0.239***	(0.008)	0.252***	(0.008)	0.212***	(0.010)
NB	0.424***	(0.006)	0.411***	(0.010)	0.429***	(0.008)	0.428***	(0.008)	0.415***	(0.010)
SK	0.338***	(0.007)	0.288***	(0.011)	0.363***	(0.008)	0.347***	(0.009)	0.323***	(0.011)
AB	0.009*	(0.005)	-0.006	(0.009)	0.015**	(0.007)	0.021***	(0.007)	-0.011	(0.009)
BC	-0.010*	(0.005)	-0.004	(0.009)	-0.020***	(0.007)	0.007	(0.007)	-0.040***	(0.009)
Time Variation										
2006	-0.067***	(0.005)	-0.081***	(0.008)	-0.059***	(0.007)	-0.051***	(0.006)	-0.091***	(0.008)
2007	-0.144***	(0.005)	-0.174***	(0.008)	-0.126***	(0.006)	-0.128***	(0.006)	-0.165***	(0.008)
2008	-0.167***	(0.005)	-0.192***	(0.008)	-0.153***	(0.006)	-0.152***	(0.006)	-0.188***	(0.008)
2009	-0.189***	(0.005)	-0.210***	(0.007)	-0.177***	(0.006)	-0.176***	(0.006)	-0.206***	(0.008)
Constant	1.801***	(0.039)	1.720***	(0.048)	2.099***	(0.073)	1.845***	(0.054)	1.690***	(0.059)
Observations	67714		26716		40998		39604		28110	

a. Robust standard errors in parentheses
b. * significant at 10%; ** significant at 5%; *** significant at 1%