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Utilisation of primary total knee joint replacements across socioeconomic status in the Barwon Statistical Division, Australia, 2006–2007: a cross-sectional study

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ABSTRACT

Objectives: There are few Australian data that examine the association between total knee joint replacement (TKR) utilisation and socioeconomic status (SES). This study examined TKR surgeries with a diagnosis of osteoarthritis (OA) performed for residents of Barwon Statistical Division (BSD) for 2006–2007.

Design: Cross-sectional.

Setting: BSD, South-eastern Victoria, Australia

Participants: All patients who underwent a TKR for OA, 2006–2007, and whose residential postcode was identified as within the BSD of Australia, and for whom SES data were available, were eligible for inclusion.

Primary outcome measure: Primary TKR data ascertained from the Australian Orthopaedic Association National Joint Replacement Registry. Residential addresses were matched with the Australian Bureau of Statistics census data, and the Index of Relative Socioeconomic Disadvantage was used to determine SES, categorised into quintiles whereby quintile 1 indicated the most disadvantaged and quintile 5 the least disadvantaged. Age-specific and sex-specific rates of TKR utilisation per 1000 person-years were reported for 10-year age bands.

Results: Females accounted for 62.7% of the 691 primary TKR surgeries performed during 2006–2007. The greatest utilisation rates of TKR in males was 7.6 observed in those aged >79 years, and in 10.2 in females observed in those aged 70–79 years.
An increase in TKR was observed for males in SES quintile four compared to quintile 1 in which the lowest utilisation which was observed (p=0.04). No differences were observed in females across SES quintiles.

Conclusions: Further investigation is warranted on a larger scale to examine the role that SES may play in TKR utilisation, and to determine whether any social disparities in TKR utilisation reflect health system biases or geographic differences.

ARTICLE SUMMARY

Article focus

- To determine whether total knee replacements (TKR) performed for arthritis were associated with socioeconomic status (SES).
- Using a comprehensive Australian registry of knee replacement surgeries, we assessed the association between quintiles of SES and TKR utilisation rates in males and females for 2006–2007.

Key messages

- Males in the most disadvantaged quintile appeared less likely to have a TKR compared to less disadvantaged males.
- No association between SES and TKR was observed for females.
- Highest rates of TKR utilisation for both sexes were observed in those aged >79 years, where increased TKR utilisation was observed for less disadvantaged males and females compared to most disadvantaged.

Strengths and limitations of this study

- TKR were ascertained from a comprehensive national registry relating to hip and knee replacements in Australia.
- The study region has been shown to be representative of the broader Australian population.
- We were unable to examine functional determinants of perceived need for TKR, or referral patterns for TKR.
- Sample size of n=691 may have limited our analyses.

INTRODUCTION

Osteoarthritis (OA) more commonly affects the knee joint, and is a leading cause of disability and reduced quality of life in the elderly.[1–3] It is well documented that knee OA is more prevalent in females than in

males,[4] and that an increased incidence is observed in females,[5] along with an increased progression of disease.[6] Given that OA is not life threatening, primary total knee joint replacement (TKR) for end-stage OA is considered as elective surgery, regardless of sex. It is a cost-effective procedure for the intervention in advanced knee OA, and has shown high efficacy in relieving pain and increasing mobility.[7 8] The number of TKR procedures performed Australia-wide was recently reported as in excess of 40 000, with a 3.7% increase from the previous year.[9]

Studies from different countries present conflicting data of the association between joint replacement and socioeconomic status (SES). In England, prior to health reform of the National Health System (NHS), individuals of greater social disadvantage were less likely to undergo TKR,[10 11] yet in Canada individuals of lower SES were more likely to have their need for TKR met than individuals of more advantage,[12] and in Finland few differences between TKR across SES groups have been reported.[13] Variations in TKR utilisations across SES have also been shown in other studies.[14–19] Given that Australia has a readily accessible, universal health system, it would be expected that the uptake of TKR surgeries would not differ between socioeconomic groups, similar to the reduced disparities in TKR observed in England following NHS reforms to improve health equity.[20] Compared to other countries, there are few Australian data examining SES and joint replacement; we have recently called for further data in an examination of hip joint replacements across SES,[21] another study identified a lower rate of knee and hip joint replacements performed for socially disadvantaged individuals compared to less disadvantaged groups,[22] and a third study identified reduced rates of joint replacement in Italian and Greek migrants to Australia compared to non-migrants.[23] Given the limited Australian data, it is imperative to gain an improved understanding of the relationship between SES and TKR in order to inform health service provision; this could be considered long overdue.

The aim of this study was to determine whether TKR procedures, primarily performed for the elderly, were associated with SES in the Barwon Statistical Division (BSD), a region located in south-eastern Australia incorporating approximately 260 000 residents (approximately 1.31% of the Australian population) in 2006, and comprising the Australian Electoral Commission Divisions of Corio, Corangamite (part) and Lalor (part).[24] Using a comprehensive registry of knee replacement surgeries across Australia, we assessed the association between quintiles of SES and TKR utilisation rates in males and females for 2006–2007 for the BSD.

MATERIALS AND METHODS

TKR procedures

Incident knee joint replacements that had been performed for OA during 2006–2007 for residents of the BSD were identified from the Australian Orthopaedic Association National Joint Replacement Registry (AOANJRR). Implementation of the AOANJRR began in 1999 and was complete nationally by mid 2002. Since that time, all hospitals (~300), both public and private, undertaking arthroplasty procedures submit data to the registry.[25] Data are matched and verified by crosslinking registry data with government separation data for all arthroplasty procedures. This verification process has established that the Registry receives information on more than 99% of all joint replacement operations. The registry monitors the performance and outcome of joint replacement procedures Australia-wide, and the data are provided via voluntary cooperation from all Australian hospitals performing joint replacement surgeries.[26] The AOANJRR has been validated against health department unit record data using a sequential multilevel matching process and coupled with the retrieval of unreported procedures, making it the most complete set of joint replacement data in Australia.[27]

Primary TKR was defined as primary replacement of the tibiofemoral joint surfaces, and in some cases also the patellofemoral joint. Both conventional and resurfacing TKR were included. Primary partial TKR or revisions were not included within this analysis.

All patients that underwent a TKR during the study period, and whose residential postcode was identified as within the BSD of Australia were eligible for inclusion. Of the 753 primary TKR procedures fulfilling these criteria, 98% (n=738) had a diagnosis of OA. The remaining TKR were for rheumatoid arthritis (n=10), tumour (n=2), avascular necrosis (n=2) or other reasons (n=1).

Socioeconomic status

Postcodes were used to identify TKR procedures for those from the BSD, and the full residential address of each patient was then matched to the corresponding Australian Bureau of Statistics (ABS) Census Collection District, an area of approximately 250 households. ABS software was used to determine the Socio-Economic Indexes For Areas (SEIFA) value from the 2006 census for each patient; SEIFA values provide a single measure to rank the level of disadvantage at the area level, not of the individual subject.[28] The SEIFA indices have been validated by analysts from ABS Regional Offices, and an external peer-review has been undertaken by a group of academic and policy research experts to examine the variables and methodology employed,[29] and the principal components analysis employed by the ABS has been shown as reliable.[29 30] The Index of Relative Socioeconomic Disadvantage (IRSD) incorporates variables that indicate people with (1) low incomes, (2) little or no training and (3) unskilled occupations, and was used for these analyses. Quintile 1 in the IRSD represented the most disadvantaged and quintile 5 represented the least disadvantage. SEIFA values were unavailable for 32 patients (4.6% of the cases, 0.02% of the total population at risk), for reasons which included: fewer than 10 people residing in an area, fewer than

5 people employed in an area, 5 or fewer occupied private dwellings in an area, or areas in which non-response to Census questions including occupation, labour force status, type of educational institution attending or non-qualifications exceeded 70%.[29] The final number of patients included in this analysis totalled 691. The AOANJRR Data Review Committee, as a Federal Quality Assurance Activity under the Health Insurance Act of 1973, approved this study.

Statistical analysis

We calculated the rates of primary TKR for 10-year age strata for men and women; these were expressed as the number of surgeries per 1000 persons per year, based on each SES quintile.

Poisson regression was used to model the age-adjusted relative risk of primary TKR per unit time stratified by sex across SES quintiles. Given the interaction between SES and sex, the model was set up as:

log(N) = log(PAR) + intercept + age group + SES + sex + SES x sex + error (where PAR=population attributable risk)

This model enables the examination of the rate of TKR (per unit of time) of N/PAR given the predictive variables of age group, SES and sex. In order to examine the rates of TKR within sex across SES groups (adjusting for age), we created post hoc comparisons of estimated N/PAR within sex across different SES quintiles (α=0.05). In order to examine the rates of TKR within sex across SES groups in the oldest age group of >79 years, we used the same model, excluding the age term. Two diagnostic plots were employed to check assumptions of the Poisson regression model; the Residual Quantile–Quantile Plot and the Residual versus Predicted Plot. The Residual Quantile–Quantile Plot showed that deviance was greater than 1, suggesting that the model was overdispersed therefore a scale parameter was used to adjust the SDs. The Residual versus Predicated Plot presented with only a slight fanning of the residuals; however, apart from this there were no systematic trends. Analyses were performed using SAS V.9.2 (SAS Institute Inc, Cary, North Carolina, USA).

RESULTS

There were 691 TKR for OA, of which females accounted for 62.7%. Table 1 presents the crude numbers and rates of TKR utilisation per 1000 person-years for each 10-year age group, sex and SES quintile. The greatest rate of TKR in the total group was observed in males aged >79 years (7.6/1000 person-years), in females aged 70–79 years (10.2/1000 person-years; table 1).

Table 2 presents the sex-specific, age-adjusted relative risks of TKR utilisation. For females, there were no significant results at the α=0.05 level from the post hoc comparisons. For males, individuals in quintile 4 had greater TKR utilisation compared to quintile 1; no other significant differences at the α=0.05 level were observed in males. Compared to quintile 1, there was an estimated increased rate of primary TKR for males in all SES groups; however, these were not-significant.

Table 1 Crude numbers and rates per 1000 person-years (based on population at risk in each socioeconomic quintile) of total knee joint replacement (TKR) replacements by age, sex and socioeconomic quintiles for 2006–2007

		Total		Quintile 1*		Quintile 2		Quintile 3		Quintile 4		Quintile 5	
	Population at risk	n=TKR†	Rate (per 1000 person-years)	n=	Rate	n	Rate	n	Rate	n	Rate	n	Rate
Males (years)													
20–29	14727	–	–	–	–	–	–	–	–	–	–	–	–
30–39	16624	–	–	–	–	–	–	–	–	–	–	–	–
40–49	18192	3	0.1	1	0.2	1	0.2	–	–	1	0.1	–	–
50–59	17020	32	0.9	6	1.0	6	1.0	5	0.7	6	0.8	6	0.8
60–69	11767	106	4.5	8	1.8	25	5.3	19	4.0	21	4.4	26	5.5
70–79	8383	80	4.8	14	3.8	22	5.9	10	3.0	19	5.8	9	3.4
>79	4361	37	4.2	5	2.9	5	2.5	5	2.5	12	7.4	10	7.6
Females (years)													
20–29	14498	1	0.0	1	0.2	–	–	–	–	–	–	–	–
30–39	17599	2	0.1	2	0.3	–	–	–	–	–	–	–	–
40–49	19367	3	0.1	1	0.1	–	–	1	0.1	1	0.1	–	–
50–59	17653	58	1.6	12	1.9	11	1.7	7	0.9	14	1.9	7	1.0
60–69	12435	103	4.1	22	4.3	29	5.8	12	2.3	22	4.4	10	2.2
70–79	9872	191	9.7	42	9.4	46	10.2	36	8.6	35	9.7	26	8.8
>79	7320	75	5.1	9	3.0	12	3.5	20	5.9	16	5.7	17	8.2

*Most disadvantaged.
†n=TKR in the total column includes primary TKR where Socio-Economic Indexes For Areas values were unavailable

Table 2 Poisson model testing for relative risk (RR) of total knee joint replacement stratified by sex, and across socioeconomic quintiles. Quintile 1 (most disadvantaged) held as reference range for both sexes

Comparison with SES quintile 1	RR	Lower 95% CI	Upper 95% CI	p Value
Males				
SES 2	1.68	0.98	2.87	0.06
SES 3	1.12	0.62	2.00	0.71
SES 4	1.76	1.03	3.01	0.04
SES 5	1.70	0.98	2.95	0.06
Females				
SES 2	1.08	0.75	1.56	0.66
SES 3	0.84	0.57	1.24	0.38
SES 4	1.09	0.75	1.59	0.66
SES 5	0.87	0.57	1.32	0.50

SES, socioeconomic status.

DISCUSSION

Males in the most disadvantaged quintile appeared less likely to have a TKR compared to less disadvantaged males; however, this was only significant between SES quintiles 1 and 4. No association was observed for females. The highest rates of TKR utilisation for both sexes were observed in those aged >79 years; increased TKR utilisation was again observed for males in quintile 5 compared to quintile 1, and this pattern was also observed for females.

Although it may be suggested that the need for a TKR does not discriminate between individuals based on their SES but instead on disease severity at end-stage OA, many lifestyle risk factors associated with OA severity, such as obesity,[31] are predominantly associated with SES in both sexes.[32 33] Therefore, greater end-stage disease may be more likely in the lower SES groups. However, our findings suggested the opposite situation, whereby increased TKR utilisation may actually exist for those of upper SES. We speculate that there may be various reasons for differences in the uptake of TKR surgeries between different socioeconomic quintiles,[34 35] especially for the elderly, which may include patterns of referral; inequitable accessibility between the public and private health system[36] or perhaps that a combination of these issues exist.

While healthcare is relatively equitable for all socioeconomic groups within Australia due to the availability of both private and public health systems, studies have suggested that social determinants of TKR utilisation may still include differential access to healthcare.[23 36] For instance, in a study of Italian and Greek migrants within Australia, similar numbers of non-Australian-born people underwent joint replacement in the public system compared to Australian-born individuals; however, differences between Australian-born and non-Australian-born patients were observed for those using the private health system.[23] Given that we observed a significant difference between quintile 4 and the most disadvantaged SES quintile for males in the total population, and disparities between SES quintiles for females when limited to patients aged >79 years, we speculate public versus private healthcare usage may remain a determinant of TKR utilisation as populations age.

In addition to accessibility, differing social factors and beliefs in those from different socioeconomic quintiles may influence health-seeking behaviour, or the willingness to undergo a TKR procedure. Given that these issues are beyond the scope of this analysis, our discussion concerning the patient's decision to undertake or refuse TKR, and decision-making processes of the prescribing health professional, are purely speculative. Functional motivations have been suggested as a key driver for uptake of TKR where access to health care is equitable, with patients who self-report a higher range of movement (ROM) more likely to postpone surgery.[37] It may be possible that individuals of lower SES have a greater threshold for functional limitations such as ROM, or perhaps given that individuals of lower SES are less likely to be physically active,[32 33 38 39] they are less likely to perform movements associated with full ROM.

Interestingly, it has been shown that TKR is more likely to be performed for males compared to females;[40–42] however, we observed the rate of TKR for females to exceed that of males in the BSD. Although speculation, there may be two explanations for this observation. Higher body mass index (BMI) is a significant predictor for the development of knee OA;[43–45] strong inverse relationship between BMI and SES is observed in a random sample of women shown as representative of the BSD population, and of the broader Australian population.[32] However, this may not fully explain the differences between sexes in our sample, as a similar relationship between BMI and SES has also been observed in males in the same geographic region.[33] Given this, we suggest that as knee OA is more common in women compared to men,[4 46] our findings suggest that SES may play a role in exacerbation or mediation of disparities between TKR and sexes.

A cross-sectional association has been demonstrated in NHANES between the demands of occupational knee bending and knee OA in persons aged 55–64 years,[47] and consistent with this was the Framingham study, which showed a relationship between occupational physical labour, knee bending and later OA, especially among males.[48] These data are supported by a case–control study in the UK, which showed an increased risk of knee OA in subjects whose main job entailed more than 30 min/day of squatting or kneeling, or climbing more than 10 flights of stairs per day, or where the job entailed heavy lifting.[49] These data suggest a role for at least one parameter of SES in knee OA. However, occupational knee bending is an unmeasured confounder in this analysis. Furthermore, it is unclear as to why the differences in TKR between upper and lower SES quintiles in men became more significant in the older age group, for whom physically demanding occupations may or may not have been a confounder, although given that the

number of TKR performed does not indicate disease prevalence, but instead symptomatic disease, the need for TKR is in part a product of activity level as well as disease severity. Nevertheless, as a greater number of TKR are performed in older individuals compared to their younger counterparts, this observation may be of little consequence unless there was a concomitant increase or decrease in the magnitude of the effect, which did not appear to be the case in this study.

One strength of this study was that the TKR were ascertained from a comprehensive national registry that has been validated against health department unit record data using a sequential multilevel matching process, and, coupled with the retrieval of unreported records, is the most complete set of data relating to hip and knee replacement in Australia. Of the TKR cases identified for 2006–2007 in the BSD, 6% could not be coded for SES, which may have influenced the association with SES. However, given that the spread of these patients was relatively equal between sexes (49% male), and represented equal proportions of the population at risk for each sex (both 0.02%), any potential disparity would be non-differential. The BSD region has been shown to be representative of the broader Australian population and thus provides an excellent location for epidemiological research. However, these observations cannot be assumed to exist in other geographic regions of Australia, or relate to the country as a whole. We were unable to examine functional determinants of perceived need for TKR, uptake and/or referral patterns for TKR, or lifestyle risk factors in our population. Furthermore, the AOANJRR database does not collect information regarding comorbidities, medications or other factors that may influence associations between SES and TKR, thus we were unable to account for these factors in our analyses. Given that sample size limited our analyses, it is imperative that this analysis be performed on a larger scale, to determine whether SES is associated with TKR for the broader Australian population.

Further investigation is warranted on a larger scale to investigate the role that SES may play in TKR utilisation, and whether this may be related to differences in referral for TKR, differences in OA prevalence or in health-seeking behaviour.

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Contributors All authors participated in the study design. SLB drafted the manuscript. TS performed the statistical analysis and SEG and SLB supervised the analysis. SLB, MAK, GCN, AEW, RSP and JAP guided and reviewed the manuscript. All authors read and approved the final manuscript.

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