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Effects of socioeconomic status on patients' outcome after total knee arthroplasty

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Abstract

Objective. To identify whether patients in lower socioeconomic groups had worse pain and functional levels prior to total knee arthroplasty and then establish whether these patients had poorer post-operative outcomes following total knee arthroplasty.

Method. Data was obtained from a prospective observational study of 974 patients undergoing primary total knee arthroplasty for osteoarthritis. The study was undertaken in 13 centers in 4 countries. Pre-operative data was collected and patients were followed for 2 years post-operatively. Pre-operative details of the patients' demographics; socioeconomic status (SES) (education and income); height; weight and co-morbid conditions were obtained. The WOMAC scores were obtained preoperatively and during follow-up.

Results. Using multivariate linear regression analysis, patients with a lower income had a significantly worse pre-operative WOMAC Pain ($P = 0.021$) and function score ($P = 0.039$) than those with higher incomes. However, income did not have a significant impact on outcome at final follow-up after adjusting for other significant covariates. Level of education did not correlate with pre-operative scores or with outcome at any time during follow-up.

Conclusion. Across all four countries, patients with lower incomes appeared to have a greater need for total knee arthroplasty. However, level of income and educational status did not appear to affect the final outcome following total knee arthroplasty. Patients with lower incomes appeared able to compensate for their worse pre-operative score and obtain similar outcomes post-operatively. These findings are in contrast to studies on other medical conditions and surgical interventions, in which a lower SES has been found to have a negative impact on patient outcomes.

Keywords: outcomes, socioeconomic status, total knee arthroplasty

Introduction

Total knee arthroplasty has established itself as an extremely efficacious treatment for patients with arthritis. Its' effects on improving physical function and reducing pain are well documented [1]. However, outcome is not solely dependent on the surgical technique and the operative procedure. Pre-operative function has been shown to be one of the strongest determinates of functional outcome after total joint arthroplasty [2] and specifically after total knee arthroplasty [3]. Other patient factors, such as mental health status [3, 4]; co-morbid medical conditions [2, 3]; patient expectations [5]; gender [4] and type of arthritis [4] have also been correlated with outcome. Limited study has been undertaken into the effects of socioeconomic factors on patient outcomes following total joint replacement.

The utilization of resources by different socioeconomic groups has been studied. Yong *et al.* demonstrated that patients who were socioeconomically deprived were approximately twice as likely to be in need of total knee arthroplasty and were less likely to be receiving services [6]. Other studies have demonstrated that patients with less formal education and lower income, worse arthritic symptoms and disability combined with a greater potential need for hip and knee arthroplasty [7].

The correlation of positive patient expectation and improved outcome after total joint arthroplasty has been demonstrated [4]. There is evidence that patients from higher

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socioeconomic groups have higher expectations of total joint arthroplasty [5]. These studies would therefore suggest that patients from higher socioeconomic groups might obtain better outcome after total joint arthroplasty.

The effect of socioeconomic status (SES) on the outcome of surgical interventions in other areas has been studied. Patients in lower socioeconomic groups have been shown to have a worse outcome in colorectal cancer [8], after liver transplantation [9] and after renal transplantation [10]. The mortality rate of elective surgery patients in the ICU has also been shown to be higher in patients with lower SES [11]. The ability to identify pre-operatively those patients who are at risk of a worse outcome following total knee arthroplasty could help in the implementation of measures that could be directed towards them in an attempt to improve their final outcomes. Our aims were to identify whether patients in lower socioeconomic groups had worse pain and function prior to total knee arthroplasty and to establish whether these patients had poorer post-operative outcomes following total knee arthroplasty.

Materials and methods

Design

Data for these analyses were obtained as part of the Kinemax Outcomes Study that was a prospective observational study of primary total knee arthroplasty for osteoarthritis in thirteen centers: four in the USA; six in the UK; two in Australia and one in Canada. The appropriate institutional review board or ethical committee approved the study at each of the participating centers. Independent research assistants at the participating sites recruited patients from September 1997 to December 1998 in the UK, the USA and Australia and in Canada recruitment extended to the end of 1999.

Patients

All patients undergoing primary total knee arthroplasty using the Kinemax prosthesis (Stryker Howmedica, NJ, USA) for primary osteoarthritis were included. Patients were excluded if they had a history of knee joint infection or prior implant surgery to the index knee or were unable to complete the questionnaires because of cognitive or language difficulties. Patients who had bilateral total knee arthroplasty within 12 months were excluded from these analyses to ensure that the follow-up results reflected the outcome of the index operation and not a subsequent surgery.

Data collection procedures

Pre-operative data were collected within 6 weeks prior to total knee arthroplasty and follow-up data were collected at 3, 12 and 24 months following surgery. One of the authors (E.A.L.) trained all research assistants to standardize data collection and data were entered into a single database at the coordinating center.

Data elements

The pre-operative questionnaire included demographic details, socioeconomic data (education, income, working status and living arrangements), height, weight and history of co-morbid conditions. The self-administered co-morbidity questionnaire has been validated with a medical record-based co-morbidity instrument as well as with subsequent health status and utilization [12]. This instrument collects information about hypertension, heart disease, lung disease, diabetes, neurological disease, depression etc., but with the exception of back pain does not give a measure of musculoskeletal co-morbidity.

The same education categories were used for all countries with the exception of the wording for item 3 which for cultural reasons was listed as 'graduated high school' for USA and Canada and 'completed high school' for UK and Australia (Table 1). We favored these categories over years of education as we believe that it gave a more explicit level of education attained by each of the participants.

At each evaluation, the WOMAC [13], a disease-specific measure of pain and function, was self-administered. We transformed WOMAC scores to a 0–100 scale for each domain (100 best).

Statistical methods

Statistical analyses were performed using the SAS Version 8.0 statistical software [14]. We used Spearman correlation coefficients to measure the strength of the association between income, education, WOMAC Pain and Function scores. We hypothesized that there would be a moderate positive correlation between income and education levels ($R > 0.50$) and that there would be a positive correlation between these SES measures and level of pain and function ($R > 0.50$ indicating less pain and functional limitation in patients with higher SES).

Multivariate linear regression analyses were used to determine if income and education status were significant independent correlates ($P < 0.05$) of pain and function using WOMAC Pain and Function scores at each assessment time as the dependent variable. In the models with pre-operative WOMAC Pain and Function as the dependent variables, we adjusted for age, gender, number of co-morbid conditions, country and center within country which have previously been shown to be independent correlates of outcome [3]. In the models with the follow-up WOMAC scores as the dependent variables, we adjusted for the above variables as well as pre-operative WOMAC Pain and Function scores. These models were tested for robustness by running the analysis with imputed values (mean value for each country) to test if the significance of the income and education variables changed. This method has been described and used in our previous publication [3]. Differences in WOMAC scores of 9–12 points on a 100-point scale have

Table I Basic demographics, clinical features and SES data at pre-operative assessment

	UK N = 430	US N = 260	Australia N = 170	Canada N = 114
Age[a]	72 (56, 84)	70 (51, 85)	70.5 (55, 81)	71 (49, 84)
Gender—*N* (%) female	250 (58)	164 (63)	95 (56)	78 (68)
Number of comorbidities[a]	1 (0, 4)	2 (0, 4)	2 (0, 4)	2 (0, 4)
N (%) >2 comorbidities	170 (40)	138 (53)	89 (52)	61 (54)
Body mass index (BMI)[a]	28 (22, 36)	31 (22, 44)	27 (22, 39)	29 (22, 39)
BMI Categories—*N* (%)				
<25	92 (23)	39 (16)	42 (26)	16 (15)
25– < 30	172 (44)	70 (29)	65 (40)	45 (42)
30– < 40	118 (30)	108 (44)	50 (31)	43 (40)
> = 40	12 (3)	27 (11)	5 (3)	4 (4)
Income category[b] (146 missing responses)—*N*(%)				
< $15 000	92 (26)	44 (19)	46 (34)	19 (18)
$15 000–$30 000	189 (54)	90 (38)	70 (52)	40 (38)
$30 000–$45 000	53 (15)	43 (20)	10 (8)	16 (15)
$45 000–$60 000	13 (4)	20 (9)	3 (2)	11 (10)
>$60 000	4 (1)	33 (14)	7 (5)	20 (19)
Education Status (27 missing responses)—*N*(%)				
Less than high school	216 (53)	17 (7)	42 (25)	11 (10)
Some high school	100(24)	28 (11)	56 (33)	31 (27)
Graduated/completed high school	41 (10)	102 (40)	38 (22)	30 (26)
Some college, technical or university	34 (8)	52 (20)	17 (10)	16 (14)
Graduated college, technical or university	11 (3)	27 (11)	13 (8)	16 (14)
Post-graduate education	7 (2)	28 (11)	4 (2)	10 (9)
Working status (4 missing responses)—*N*(%)				
Working full-time	21 (5)	45 (17)	12 (7)	14 (12)
Working part-time	7 (2)	17 (7)	9 (5)	7 (6)
Homemaker full-time	23 (5)	30 (12)	23 (14)	12 (10)
Student full-time	1	0	0	0
Unemployed, looking for work	1	0	0	0
Disabled and unable to work	38 (9)	24 (9)	7 (4)	14 (12)
Retired	336 (79)	143 (55)	119 (70)	67 (59)
Pre-operative scores				
WOMAC Pain[a]	40 (5, 65)	40 (0, 75)	45 (15, 80)	40 (5, 75)
WOMAC Function[a]	41 (12, 76)	47 (10, 75)	50.5 (26, 85)	47 (7, 76)

[a]Scores reported are the medians (95% confidence interval); [b]Income categories were created for each country based on the middle level covering the gross median household income for that country at the time of the study. The lowest income category was half the lower limit of the middle category (<~ 40% of gross median household income) and the highest income category was > twice the lower limit of the middle category. The country specific categories using the appropriate currency for that country were used in the in the respective questionnaires for each country. For presentation purposes we include the US income category only.

been shown to be perceptible to patients and are clinically meaningful [15].

Results

A total of 1249 (78.6%) of all eligible patients were recruited. Reasons for eligible patients not being recruited were: (i) 128 (8.1%) refused consent, (ii) 197 (12.4%) were missed pre-operatively due to absence of the research assistant for sickness or vacation or were not recruited because of insufficient time to inform, consent and evaluate prior to surgery and (iii) 14 (0.9%) patients were already enrolled in another study and Ethical/IRB protocol at this site did not allow their recruitment into more than one study. During the recruitment period only 6% of all primary total knee arthroplasty patients operated on by the participating surgeons did not have a Kinemax Plus prosthesis, frequently because a more constrained prosthesis was required. After exclusion of 275 patients, who had bilateral total knee

arthroplasty within 12 months, a total of 974 met the inclusion criteria.

A total of 430 (44%) patients were from the UK, 260 (27%) patients were from the USA, 170 (17%) patients were from Australia and 114 (12%) patients were from Canada. A total of 181(18.1%) of patients had data missing at follow-up assessments. Thirty-five (3.5%) had died, 19(1.9%) had other illness preventing them from attending, 17(1.7%) had revision total knee arthroplasty, 46(4.6%) withdrew, 12(1.2%) moved away, 40(4%) were lost to follow-up and 12(1.2%) were unable to attend but were still in the study. There was no significant difference in responders and non-responders at each follow-up time in terms of age, gender or education status but non-responders at 12 and 24 months reported significantly lower incomes at pre-operative assessment ($P = 0.04$ and 0.02, respectively). Table 1 shows the basic demographic data and clinical features at pre-operative assessment of the cohort. The UK patients were significantly older ($P = 0.017$) but there was no significant difference in the gender proportion between the countries. The UK patients reported significantly fewer co-morbid medical conditions compared to the other three countries ($P = 0.0001$). The US patients had significantly higher BMI with 27 (11%) being morbidly obese ($P < 0.0001$). Patients from the UK had significantly worse pre-operative function limitation than the other countries (lower WOMAC Function scores, $P < 0.0001$) and patients from Australia reported significantly less pain (higher WOMAC scores, $P < 0.0001$) than the other countries pre-operatively.

Table 1 shows the SES variables by country and illustrates that there was marked variation in these measures with patients from the USA and Canada reporting higher levels of education and income. These patients were also more likely to still be working compared with the high levels of retired patients in the UK (79%) and Australia (70%). Income and education were modestly correlated ($R = 0.39$) but correlations between these SES variables and WOMAC Pain and Function scores at each evaluation time were weak ($R < 0.20$ in all instances).

The data from the analyses by country are limited as in some countries there were relatively few participants in the higher income and education categories reducing the ability to draw conclusions alone from this data (Table 1). Therefore, due to the differences between countries and centers within countries we adjusted for country and center within country in our models that included all data. In the models which combined all of the data, level of income was a significant correlate of pre-operative WOMAC Pain ($P = 0.021$) and Function ($P = 0.039$) with lower income being associated with lower WOMAC scores. Income did not have a significant impact on outcome except for WOMAC Pain at 12-months ($P = 0.014$) but at all other assessment times for WOMAC Pain and all follow-up assessments of WOMAC Function, income was not a significant correlate. The adjusted mean scores for WOMAC Pain and Function by income category (Table 2) and education category (Table 3) shows the magnitude in the differences in these scores. At no time was educational status a significant correlate of WOMAC Pain and Function. There

Table 2 Mean WOMAC Pain and Function scores at each assessment time by income categories

	Pre-operative number	Pre-operative	3-month	12-month	24-month	24-month number
WOMAC pain						
<$15 000	200	38.3	69.6	78.0	82.8	145
$15 000–30 000	386	42.1	73.7	83.2	85.2	308
$30 000–45 000	127	39.8	71.2	80.5	80.7	100
$45 000–60 000	47	45.0	75.6	82.3	81.6	38
>$60 000	63	47.2	76.5	87.0	88.2	52
P-value*		0.021	0.070	0.014	0.071	
WOMAC function						
<$15 000	201	44.0	69.0	70.9	73.1	145
$15 000–30 000	389	48.7	71.2	75.0	76.0	309
$30 000–45 000	127	47.8	69.3	71.3	71.3	99
$45 000–60 000	47	49.2	71.9	73.5	73.1	38
>$60 000	64	51.0	72.7	75.7	77.2	52
P-value*		0.04	0.40	0.11	0.14	

Mean scores are adjusted for age, gender, education, number of comorbid medical conditions, country and center within country and at follow-up for the respective pre-operative score.Income categories were created for each country based on the middle level covering the gross median household income for that country at the time of the study. The lowest income category was half the lower limit of the middle category (<~ 40% of gross median household income) and the highest income category was > twice the lower limit of the middle category. The country specific categories using the appropriate currency for that country were used in the respective questionnaires for each country. For presentation purposes we include the US income category only; **P*-value reported is for the significance of the F-value for the income variable in the general linear models from which the adjusted means were calculated.

Table 3 Mean WOMAC Pain and Function scores at each assessment time by education categories

	Pre-operative number	Pre-operative	3-month	12-month	24-month	24-month number
WOMAC pain						
Less than high school	285	40.4	72.6	82.0	82.1	213
Some high school	213	40.7	72.2	82.0	82.1	167
Graduation/completed high school	210	43.6	73.9	82.8	81.8	176
Some college, technical or university	118	44.7	73.5	83.8	85.3	98
Graduated college, technical or university	67	44.2	73.6	81.2	87.4	49
Post-graduate education	48	41.4	74.0	81.2	83.4	35
P-value*		0.36	0.98	0.96	0.41	
WOMAC function						
Less than high school	284	46.5	71.1	73.1	73.1	213
Some high school	215	47.4	70.4	72.3	71.8	165
Graduation/completed high school	211	47.4	71.6	73.6	72.7	177
Some college, technical or university	119	49.6	70.6	73.7	77.1	98
Graduated college, technical or university	67	48.7	69.7	72.6	76.3	48
Post-graduate education	49	49.2	71.5	73.5	73.8	35
P-value*		0.82	0.97	0.96	0.40	

Mean scores are adjusted for age, gender, income, number of comorbid medical conditions, country and center within country and at follow-up for the respective pre-operative score; **P*-value reported is for the significance of the F-value for the income variable in the general linear models from which the adjusted means were calculated.

was considerable income data missing with 146 patients (15%) not entering a response for this question. For this reason using all data, we ran the models again using missing value substitution (mean value for each country) and found that the significance level of income and education was not altered.

Discussion

Our results demonstrated that patients with a lower income have significantly worse pre-operative WOMAC Pain and Function scores than those with higher incomes. This finding substantiates the correlation between lower income and worse pre-operative scores, which has previously been demonstrated across different countries' health care systems [6, 16]. However, in our study this did not translate into worse post-operative outcome at final follow-up. Lower income patients did have significantly worse WOMAC pain scores at twelve months post-operatively ($P = 0.014$); but by 24 months this difference was no longer significant. Education status did not significantly affect outcome at any time during follow-up.

Lower income has been associated with barriers to access total knee arthroplasty especially in health care systems such as that in the USA that rely predominantly on private health insurance [17]. One common explanation for this disparity is that patients with a lower income are less likely to have private health insurance and may therefore wait longer for surgery. This may explain the disparity in the USA and Australia where there is an established private health care system. However, the same barriers to access in the UK and Canada are much more difficult to explain. The UK still relies heavily on the National Health Service, which provides equal access to care, irrespective to income. In a previous study undertaken in the UK, lower rates of total joint arthroplasty were found in patients with lower SES; however, they paradoxically found that overall rates of consultation for arthritis were greater in these patients [18]. The effect of SES has also been studied in Canada where universal access to health care is available according to need with no private health care access. In this model of health care, SES also affected utilization of health services [19]. It has therefore been suggested that the reason why patients with a lower socio-economic status have a greater unmet need for total joint arthroplasty is multi-factorial and does not solely relate to the discrepancy in waiting times in the private and public health care systems. The disparity in the apparent access to total knee arthroplasty between different socioeconomic groups is a concern to those studying quality of care. The disparity potentially highlights a group of patients for whom the best care may not be provided. This information can be used by health care planners to target these groups and ensure that equitable access to health care services is available for all.

Our studies finding that socioeconomic factors do not appear to correlate with a worse post-operative outcome following total knee arthroplasty is unexpected. Previous studies in other specialities have shown disparities in the outcome of patients from different socioeconomic groups [8–11]. Factors that may disadvantage patients in the lower socioeconomic groups may include a reduction in comprehension of health literature and risk factors; poor symptom recognition combined with a decreased ability to navigate the health

system and an unwillingness and lack of desire to receive treatment: in addition to provider factors, such as the stereotyping of patients [20, 21] and less time being spent with less well-educated patients [22], potentially leading to a disparity in both referral for surgery and decision to operate [7]. These biases may certainly have an effect on patients' access to total joint arthroplasty services as has been demonstrated by our study and others [2, 7, 16]. It has been shown that patients with less formal education had a decreased perception of the benefits from exercise compared to those who had attained more education, thereby reducing their motivation to adhere to exercise recommendations [23, 24], which may negatively affect outcomes. However, the results of our study demonstrated that patients with lower SES do not have an inferior outcome at 2 years.

Pre-operative status has consistently been shown to be the strongest determinant of post-operative pain and functional outcome, both in the immediate post-operative period and up to 2-years post-operatively [2, 3]. However, our study illustrated that despite patients with lower incomes having significantly worse pre-operative WOMAC Pain and Function scores, there was no significant difference at the 2-year review. This observation is analogous to the discrepancies between male and female patients undergoing total joint arthroplasty. It has been consistently shown that women have worse pre-operative pain and functional scores [17, 18]. However, women do not appear to have significantly worse post-operative scores, highlighting a larger improvement in pain and functional outcome [3].

We accept that within this study there are certain limitations. The education and income categories we used were fairly basic measures of SES. The grouping of educational achievement is difficult to standardize between the different countries. Our study highlights that patients from the USA and Canada appeared to have higher levels of education compared to the other countries. This may be accounted for by the fact that in North America the education system is structured to encourage a large proportion of students to continue with education following high school. The fact that patients in the USA and Canada also had higher incomes than those in the UK and Australia may also be partially explained by the fact that patients in North America were more likely to still be employed and were significantly younger than patients in the UK who were more likely to be retired. Using income to assess SES in the retired population has inherent difficulties, although with the inclusion of income from investments and pensions we would hope to reduce some of this error. However, this will still lead to a bias in this particular group, as an underestimation of income may potentially occur. The difficulties of studying patients across different health care settings has previously been well documented [25]. Our study was limited as we recruited patients from specific surgeons and centers rather than a population-based cohort. This study was performed on a data set collected from a cohort of patients that had originally been recruited for the purpose of another study. However, the strengths of this study include the collection of very detailed data on a large number of patients and high rates of follow-up at 2 years being obtained allowing for important confounding variables to be adjusted for in the multivariate analyses.

Conclusion

This study demonstrated that patients with lower incomes had worse pre-operative pain and functional limitation. This may suggest that there is a greater unmet need for total knee arthroplasty in this group of patients. However, level of income and educational status did not affect the 2-year outcome following total knee arthroplasty. Patients with lower income appear to be able to compensate for their worse pre-operative score and obtain similar outcomes post-operatively. These findings are in contrast to studies on other medical conditions and surgical interventions in which SES has been found to have a negative impact on patient outcomes.

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References

1. Hawker G, Wright J, Coyte P, Paul J, Dittus R, Croxford R *et al.* Health-related quality of life after knee replacement. *J Bone Joint Surg Am* 1998;**80**:163–73.
2. Fortin PR, Penrod JR, Clarke AE, St-Pierre Y, Joseph L, Belisle P *et al.* Timing of total joint replacement affects clinical outcomes among patients with osteoarthritis of the hip or knee. *Arthritis Rheum* 2002;**46**:3327–30.
3. Lingard EA, Katz JN, Wright EA, Sledge CB. Predicting the outcome of total knee arthroplasty. *J Bone Joint Surg Am* 2004;**86-A**:2179–86.
4. Sharma L, Sinacore J, Daugherty C, Kuesis DT, Stulberg SD, Lewis M *et al.* Prognostic factors for functional outcome of total knee replacement: a prospective study. *J Gerontol A Biol Sci Med Sci* 1996;**51**:M152–7.
5. Mahomed NN, Liang MH, Cook EF, Daltroy LH, Fortin PR, Fossel AH *et al.* The importance of patient expectations in predicting functional outcomes after total joint arthroplasty. *J Rheumatol.* 2002;**29**:1273–9.
6. Yong PF, Milner PC, Payne JN, Lewis PA, Jennison C. Inequalities in access to knee joint replacements for people in need. *Ann Rheum Dis* 2004;**63**:1483–9.
7. Hawker GA, Wright JG, Glazier RH, Coyte PC, Harvey B, Williams JI *et al.* The effect of education and income on need and willingness to undergo total joint arthroplasty. *Arthritis Rheum* 2002;**46**:3331–9.
8. Hole DJ, McArdle CS. Impact of socioeconomic deprivation on outcome after surgery for colorectal cancer. *Br J Surg* 2002;**89**:586–90.
9. Yoo HY, Thuluvath PJ. Outcome of liver transplantation in adult recipients: influence of neighborhood income, education, and insurance. *Liver Transpl* 2004;**10**:235–43.
10. Rovelli M, Palmeri D, Vossler E, Bartus S, Hull D, Schweizer R. Noncompliance in renal transplant recipients: evaluation by socioeconomic groups. *Transpl Proc* 1989;**21**:3979–81.
11. Hutchings A, Raine R, Brady A, Wildman M, Rowan K. Socioeconomic status and outcome from intensive care in England and Wales. *Med Care* 2004;**42**:943–51.
12. Sangha O, Stucki G, Liang MH, Fossel AH, Katz JN. The self-administered comorbidity questionnaire: a new method to assess comorbidity for clinical and health services research. *Arthritis Rheum* 2003;**49**:156–63.
13. Bellamy N, Buchanan WW, Goldsmith CH, Campbell J, Stitt LW. Validation study of WOMAC: a health status instrument for measuring clinically important patient relevant outcomes to antirheumatic drug therapy in patients with osteoarthritis of the hip or knee. *J Rheumatol* 1988;**15**:1833–40.
14. Cary N. **SAS/STAT:** User's Guide Release 6.03. SAS Institute; 1988.
15. Ehrich EW, Davies GM, Watson DJ, Bolognese JA, Seidenberg BC, Bellamy N. Minimal perceptible clinical improvement with the Western Ontario and McMaster Universities osteoarthritis index questionnaire and global assessments in patients with osteoarthritis. *J Rheumatol* 2000;**27**:2635–41.
16. Lavernia CJ, Lee D, Sierra RJ, Gomez-Marin O. Race, ethnicity, insurance coverage, and preoperative status of hip and knee surgical patients. *J Arthroplasty* 2004;**19**:978–85.
17. Gittelsohn AM, Halpern J, Sanchez RL. Income, race, and surgery in Maryland. *Am J Public Health* 1991;**81**:1435–41.
18. Chaturvedi N, Ben-Shlomo Y. From the surgery to the surgeon: does deprivation influence consultation and operation rates? *Br J Gen Pract* 1995;**45**:127–31.
19. Humphries KH, van DE. Income-related health inequality in Canada. *Soc Sci Med* 2000;**50**:663–71.
20. van RM, Burke J. The effect of patient race and socio-economic status on physicians' perceptions of patients. *Soc Sci Med* 2000;**50**:813–28.
21. Wong MD, Shapiro MF, Boscardin WJ, Ettner SL. Contribution of major diseases to disparities in mortality. *N Engl J Med* 2002;**347**:1585–92.
22. Fiscella K, Goodwin MA, Stange KC. Does patient educational level affect office visits to family physicians? *J Natl Med Assoc* 2002;**94**:157–65.
23. Dexter P, Brandt K. Relationships between social background and medical care in osteoarthritis. *J Rheumatol* 1993;**20**:698–703.
24. Neuberger GB, Kasal S, Smith KV, Hassanein R, DeViney S. Determinants of exercise and aerobic fitness in outpatients with arthritis. *Nurs Res* 1994;**43**:11–17.
25. Lingard EA, Berven S, Katz JN. Management and care of patients undergoing total knee arthroplasty: variations across different health care settings. *Arthritis Care Res* 2000;**13**:129–36.

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