Direct and Indirect Costs of Osteoarthritis in Singapore: A Comparative Study Among Multiethnic Asian Patients with Osteoarthritis

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ABSTRACT. ***Objective.*** To estimate and compare the direct and indirect costs of osteoarthritis (OA) in multiethnic Asian patients with OA in Singapore.

Methods. The study was a retrospective and cross-sectional design. Patients were stratified according to ethnicity and presence or absence of joint surgery. Direct costs were estimated from both a societal and a patient perspective using the Singapore General Hospital database; indirect costs were estimated using the human capital approach. All costs were expressed as mean costs per patient per annum in 2003 Singapore dollars.

Results. A total of 1179 patients (83.6% Chinese, 7.2% Malay, 3.5% Indian, 5.7% others) were included in estimating direct costs, of which 513 (43.5%) had total knee replacement (TKR) and 92 (7.8%) total hip replacement (THR), while 105 patients (71.4% Chinese, 14.3% Malay, 14.3% Indian) were included in estimating indirect costs. Direct costs to patients ranged from $1460 to $7477 for Chinese, $1362–$7211 for Malays, $1688–$6226 for Indians, and $1437–$12,140 for other ethnic patients; direct costs to society ranged from $3351 to $15,799 for Chinese, $2939–$15,436 for Malays, $3150–$10,990 for Indians, and $2597–$17,879 for other ethnic patients. In contrast, the indirect costs ranged from $1215 to $3834 for Chinese, $1138–$6116 for Malays, and $1371–$5292 for Indians. However, most ethnic variations were not statistically significant.

Conclusion. The economic burden of OA to society and patients increased by 3-fold or more in the patients with TKR/THR compared to those without. The ethnic differences in health resources consumed were more apparent when the disease progressed. (J Rheumatol 2007;34:165–71)

Key Indexing Terms:
COST OF ILLNESS OSTEOARTHRITIS ETHNIC GROUP ASIA SINGAPORE

Osteoarthritis (OA), one of the most common chronic diseases worldwide, is characterized by pain and physical disability, which leads to significant use of healthcare resources. It therefore imposes a substantial economic burden on patients, healthcare providers, governments, and the society as a whole. The cost of OA has been estimated to account for up to 1% to 2.5% of the gross national product (GNP) in several Western developed countries[1]. The only published study of the cost of OA from Asia estimated that the cost of OA accounted for 0.28% of GNP in Hong Kong[2]. As healthcare resources are finite, it is important to understand the economic burden of the disease, which may be useful in increasing the awareness of the public and helping decision makers to allocate healthcare resources in a more efficient way. With the aging of populations worldwide, the cost of OA has been receiving growing attention in Western countries[3-10]. However, there are not sufficient studies performed in Asian countries, although the prevalence and incidence of OA are high[11-15] and are expected to increase in the region.

We therefore estimated and compared the direct and indirect costs of OA in multiethnic Asian patients with OA in Singapore. There appear to be 2 advantages to evaluating costs of OA in Singapore, a westernized Asian country with a multiethnic population, comprising 3 major ethnic groups,

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namely, Chinese (76% of total population in Singapore), Malay (14%), and Indian (8%)[16]. First, it would allow comparison between Singapore and other developed Western countries, as Singapore has one of the most developed healthcare systems, based on the Western model. The level and quality of medical care in Singapore is comparable to most developed countries. At the same time, it would provide valuable benchmark data for other countries in the region. Second, it would provide information whether OA would impose a different financial burden on different population groups (because of cultural and other habits) and thus form the basis for similar studies in other Asian countries with the same ethnic groups (China, India, etc.).

MATERIALS AND METHODS

The study was a retrospective and cross-sectional design, with institutional review board approval. Patients were stratified according to ethnicity and presence or absence of total joint replacement surgery. Direct and indirect costs of OA were estimated separately and expressed as mean costs (standard deviation) per patient per annum in 2003 Singapore dollars [exchange rate, 1 US dollar = 1.7 Singapore dollars (SGD)].

Estimation of direct costs of OA. Direct costs, defined as all resources consumed associated with the provision of an intervention or treatment for an illness[17], were estimated from both societal and patient perspectives over a period of 1 year, 2003. Direct costs were retrieved from the database of Singapore General Hospital, one of 2 tertiary referral hospitals in Singapore. The selection criteria were as follows: (1) patients were diagnosed with at least one of the following ICD-9-CM codes: 715.0x, 715.1x, 715.2x, 715.3x, 715.8x, 715.9x; (2) patients were seen in the hospital during the study year; and (3) the 12-month cost data starting from the first admission in the study year were available.

Based on the literature[18,19], the direct costs associated with OA were classified into 7 major categories, namely, professional costs, treatment and procedure costs, equipment and material costs, inpatient costs, diagnosis costs, medication costs, and miscellaneous costs. If the costs incurred by a patient were not relevant to OA based on clinical experience, these costs were excluded from classification in order to minimize the bias of comorbidity-incurred expenditures on cost estimation. Two authors (FX, JT) independently completed the classification and any disagreements were resolved by consensus among all authors. The mean proportion of costs unrelated to OA was 36% of total costs for patients with comorbidities (there was no need for such classification for patients without comorbidities). Of note, expenses charged were normally used as a proxy for cost in published cost of illness studies[4,8], and was also adopted in this study based on several considerations. First, this is the only available information, as cost data are sensitive and confidential. Second, the study hospital is one of the major publicly funded not-for-profit healthcare providers in Singapore. It is expected that the charge for services rendered would be reasonably close to the cost of providing the service.

Estimation of indirect costs of OA. Indirect costs, defined as the productivity loss incurred by an illness[17,20-22], were estimated using the human capital approach[2,6,7,10,23] through face to face interviews. Patients were conveniently recruited from the Departments of Rheumatology and Immunology and Orthopaedic Surgery at Singapore General Hospital, and could be considered a subgroup of patients included in the estimation of direct costs. All patients were diagnosed with OA by their attending rheumatologist or orthopedic surgeon; written informed consent was obtained for each participating patient.

The method of estimating indirect costs was different for working patients and nonworking patients. Working patients were asked to estimate the number of days of absence from work due to OA in the past year (full productivity is assumed when working patients resume their work). Retirees/homemakers were asked to estimate a percentage of productivity lost due to OA, with an assumption of 100% productivity before they had been diagnosed with OA. As data for individual earnings were not available, indirect costs for those who were working were calculated by multiplying the number of days of absence from work (as recalled by patients and confirmed by their physicians) by average earnings per day in Singapore between 1993 and 2003 (i.e., $139)[16], and for retirees/homemakers by multiplying productivity loss by current market value for housekeeping and leisure activities.

Statistical analyses. Data were entered into a Microsoft Excel spreadsheet (Microsoft, Redmond, WA, USA) and analyzed using Stata Intercooled v.8 (Stata Corp., College Station, TX, USA). Comparing demographic characteristics across ethnic groups, analysis of variance was used for continuous variables and Pearson chi-square test for categorical variables. As the cost distribution was skewed, the Kruskal-Wallis H test was applied to test differences in costs across ethnic groups without adjustment for age and sex. Regression analyses with log-transformed direct and indirect costs as dependent variables and age, sex, and ethnicity as independent variables were also performed to check differences in costs across ethnicities with adjustment for age and sex. All statistical analyses were conducted at a significance level of 0.05 and all tests were 2-tailed if appropriate.

RESULTS

Patient characteristics. A total of 1179 patients (83.6% Chinese, 7.2% Malay, 3.5% Indian, and 5.7% others) fulfilling the inclusion criteria were included in the estimation of direct costs of OA. The demographic characteristics of patients are shown in Table 1. Chinese patients were significantly older than patients in other groups ($p < 0.001$). There were more female Chinese and Malay patients compared with Indian and other ethnic groups ($p = 0.005$). The distribution of OA types was generally similar across ethnic groups, and the knee was the most frequently affected joint across all groups. The percentages of patients with total knee replacement (TKR) or total hip replacement (THR) were significantly higher for Chinese (46.2% and 8.2%, respectively) and lower for Indian patients (3.4% and 4.9%).

A total of 120 patients were admitted to hospital during the period for estimating indirect costs. As shown in Table 2, 105 patients (71.4% Chinese, 14.3% Malay, and 14.3% Indian) participated in estimation of the indirect costs of OA. Knee OA was seen more frequently in Chinese than Malay and Indian patients (92.0% vs 86.7%; $p = 0.63$). The percentage of patients with TKR was highest for Malay patients (33.3%) and lowest for Indian patients (13.3%) ($p = 0.52$). More than 70% of the patients were retirees or homemakers across the 3 ethnic groups. Household income was generally similar across the 3 ethnic groups.

Direct costs of OA. Of 1179 patients, 574 (48.7%) did not undergo surgery, 513 had TKR (43.5%), and 92 had THR (7.8%). The mean direct costs to society and to patients were $3245 and $1459, respectively, for those without joint surgery, $11,429 and $5561 for those with TKR, and $15,763 and $7555 for those with THR, respectively. Detailed cost information across different groups is given in Table 3. The main expense across all ethnic groups was

Table 1. Characteristics of patients in estimation of the direct costs of OA.

	No. (%) Unless Stated					
	Chinese, n = 986	Malay, n = 85	Indian, n = 41	Other, n = 67	Total n = 1,179	p*
Age, yrs						< 0.001
Mean (SD)	69.0 (11.5)	63.0 (12.7)	63.2 (11.9)	64.0 (14.1)	68.1 (12.0)	
Median (IQR)	70.0 (16.0)	64.0 (17.0)	63.0 (18.0)	68.0 (25.0)	70.0 (17.0)	
Female	756 (76.7)	65 (76.5)	28 (68.3)	39 (58.2)	888 (75.3)	0.005
OA type						0.519
Knee	843 (85.5)	74 (87.1)	35 (85.4)	55 (82.1)	1,007 (85.4)	
Hip	59 (6.0)	6 (7.1)	2 (4.9)	2 (3.0)	69 (5.9)	
Other**	84 (8.5)	5 (5.9)	4 (9.7)	10 (14.9)	103 (8.7)	
Surgery						< 0.001
TKR	456 (46.2)	22 (25.9)	14 (3.4)	21 (31.3)	513 (43.5)	
THR	81 (8.2)	5 (5.9)	2 (4.9)	4 (6.0)	92 (7.8)	
With comorbidity	808 (81.9)	66 (77.6)	28 (68.3)	50 (74.6)	952 (80.8)	0.067

* Kruskal-Wallis H test for continuous variable (age) and Pearson chi-square test for categorical variables. ** Other types of OA include multiple sites (n = 17), ankle and foot (n = 15), hand (n = 14), shoulder (n = 14), unspecified sites (n = 10), forearm (n = 4), and upper arm (n = 3). OA: osteoarthritis; SD: standard deviation; IQR: interquartile range; TKR: total knee replacement; THR: total hip replacement.

Table 2. Characteristics of patients in estimation of indirect costs of OA.

	No. (%) Unless Stated				
	Chinese, n = 75	Malay, n = 15	Indian, n = 15	Total n = 105	p*
Age, yrs					0.007
Mean (SD)	64.2 (8.5)	63.2 (10.8)	60.7 (8.3)	63.6 (8.8)	
Median (IQR)	64.0 (14.0)	67.0 (19.0)	58.0 (9.0)	64.0 (14.0)	
Female	57 (76.0)	12 (80.0)	11 (73.3)	80 (76.2)	0.910
Married	57 (76.0)	9 (60.0)	12 (80.0)	78 (74.3)	0.373
OA type					0.626
Knee	69 (92.0)	13 (86.7)	13 (86.7)	95 (90.5)	
Hip	6 (8.0)	2 (13.3)	2 (13.3)	10 (9.5)	
Surgery					0.519
TKR	14 (18.7)	5 (33.3)	2 (13.3)	21 (20.0)	
THR	2 (2.7)	1 (6.7)	1 (6.7)	4 (3.8)	
With comorbidity	49 (65.3)	8 (53.3)	13 (86.7)	70 (66.7)	0.138
Retirees/homemakers	61 (81.3)	12 (80.0)	11 (73.3)	84 (80.0)	0.779
Monthly household income (SGD)					0.967
< 1,000	20 (26.7)	4 (26.7)	5 (33.3)	29 (27.6)	
1,000–2,999	33 (44.0)	8 (53.3)	7 (46.7)	48 (45.7)	
3,000–4,999	12 (16.0)	2 (13.3)	2 (13.3)	16 (15.2)	
> 5,000	10 (13.3)	1 (6.6)	1 (6.6)	12 (11.4)	

* ANOVA for continuous variables and Pearson chi-square test for categorical variables. OA: osteoarthritis; SD: standard deviation; IQR: interquartile range; TKR: total knee replacement; THR: total hip replacement. SGD: Singapore dollars: 1 US dollar = 1.7 SGD.

treatment and procedure costs, regardless of the presence or absence of TKR or THR.

Among patients without joint surgery, the magnitude of direct costs in each cost category was generally similar across ethnic groups. Chinese patients incurred statistically higher diagnosis costs (p = 0.014). Indian patients incurred slightly higher professional costs for treatment and procedures, and equipment and material costs (all p > 0.1). Chinese patients incurred the highest inpatient treatment costs and medication costs, while patients in other ethnic groups had the lowest inpatient and medication costs. The total direct costs to society were highest for Chinese patients ($3351) and lowest for other ethnic patients ($2597) (p = 0.172). In contrast, the total direct costs to patients were highest for Indians ($1689) and lowest for Malay patients ($1363) (p = 0.894). After adjustment of age and sex, the differences in professional costs, inpatient costs, diagnostic costs, and total average cost to society across ethnic groups retained statistical significance (data not shown).

Table 3. Direct costs of osteoarthritis. Data are mean (SD) per patient per annum. All costs are Singapore 2003 dollars.

	Patients without Surgery					**Patients with TKR**					**Patients with THR**					**Total n=1179**
	Chinese n=449	Malay n=58	Indian n=25	Other n=42	Subtotal n=574	Chinese n=456	Malay n=22	Indian n=14	Other n=21	Subtotal n=513	Chinese n=81	Malay n=5	Indian n=2	Other n=4	Subtotal n=92	
Professional costs	**504** (671)	**490** (689)	**658** (808)	**642** (636)	**519** (676)	2952 (540)	3043 (460)	2904 (1081)	3154 (488)	2963 (556)	**3052** (1360)	**2054** (1079)	**1538** (1800)	**2928** (515)	**2959** (1349)	1773 (1411)
Treatment and procedure costs	1277 (1093)	1141 (1195)	1333 (1437)	1121 (883)	1254 (1095)	**6490** (1343)	**7064** (1308)	**5894** (1605)	**6513** (1316)	**6500** (1353)	**7845** (2683)	**6542** (503)	**4796** (1867)	**7238** (1862)	**7682** (2603)	4038 (3058)
Equipment and material costs	78 (98)	81 (100)	116 (114)	74 (95)	80 (99)	271 (84)	286 (86)	302 (89)	271 (80)	272 (84)	339 (154)	359 (301)	228 (44)	369 (200)	339 (163)	184 (143)
Inpatient costs	**1096** (1067)	**885** (917)	**768** (642)	**564** (683)	**1022** (1024)	1342 (902)	1337 (673)	1584 (1689)	1353 (728)	1349 (915)	3133 (3797)	3924 (3999)	3415 (3486)	5887 (5499)	3302 (3854)	1342 (1540)
Diagnosis costs	**371** (315)	**316** (246)	**251** (181)	**188** (121)	**347** (298)	316 (251)	281 (166)	275 (182)	323 (204)	314 (245)	1058 (1372)	1747 (2167)	785 (198)	1250 (1148)	1098 (1390)	390 (511)
Medication costs	19 (45)	17 (35)	16 (34)	4 (12)	18 (42)	15 (38)	14 (19)	27 (74)	13 (19)	15 (39)	339 (1544)	779 (1146)	0 (0)	183 (278)	349 (1473)	43 (421)
Miscellaneous costs	6 (45)	8 (44)	8 (22)	4 (16)	6 (43)	17 (92)	6 (17)	5 (19)	0 (0)	16 (87)	34 (140)	11 (24)	75 (106)	22 (44)	33 (133)	13 (75)
Total average cost to the society	**3351** (2328)	**2939** (2101)	**3150** (2521)	**2597** (1812)	**3245** (2286)	**11,404** (1927)	**12,032** (1886)	**10,991** (2751)	**11,627** (1986)	**11,429** (1954)	15,800 (7484)	15,436 (6141)	10,837 (229)	17,878 (8411)	15,762 (7346)	7783 (5400)
Total average cost to patient	1460 (1379)	1363 (1151)	1689 (1409)	1437 (1367)	1459 (1356)	**5445** (3291)	**7211** (4428)	**4733** (3979)	**6902** (4215)	**5561** (3427)	**7478** (6778)	**6243** (3475)	**6227** (5121)	**11,430** (2635)	**7555** (6499)	3719 (3792)

OA: osteoarthritis; TKR: total knee replacement; THR: total hip replacement. Data shown in bold type if there was statistically significant ethnic difference for a cost category with adjustment of age and sex. 1 US dollar = 1.7 Singapore dollar.

Among those with TKR, Malay patients incurred the highest treatment and procedure costs ($7064), while Indian patients incurred the highest inpatient costs ($1584), but neither analysis reached statistical significance. However, the total direct costs to Malay patients with TKR ($7211) were significantly higher than for other ethnic groups ($p = 0.021$). There were statistically significant differences in treatment costs, total average cost to society, and total average cost to patients across ethnic groups after adjustment for age and sex.

Among those with THR, Chinese patients incurred higher professional costs and treatment and procedure costs ($3052), while patients in other groups incurred the highest inpatient costs ($5887). The total direct costs to society and patients were highest for patients in other ethnic groups ($17,878 and $11,430, respectively) and lowest for Indian patients ($10,837 and $6227). There were statistically significant differences in professional costs, treatment costs, and total average cost to patient across ethnic groups after adjustment for age and sex.

Indirect costs of OA. Among the patients without surgery, the average days of absence from work, productivity losses, and indirect costs were similar across all ethnic groups (Table 4). In contrast, for patients with TKR or THR, Malay patients reported more days of absence from work and higher level of productivity losses (97.5 days and 67.5%, respectively) than the other 2 ethnic groups. Consequently, the indirect costs were higher for Malay patients ($6116) and lowest for Chinese patients ($3834). Again, none of these findings reached statistical significance. Notably, after adjustment for age and sex, no statistical significance remained for the differences in indirect costs across ethnic groups.

DISCUSSION

We estimated the direct and indirect costs of OA among different ethnic groups in Singapore. Two observations were evident from the results. First, the economic burden of OA to society and the patients could increase by more than 3-fold in patients with TKR or THR compared to those without surgery. Second, the ethnic group differences in health resource consumption became more apparent when the disease progressed, as the differences between the group that incurred the highest total average cost to society and the group with the lowest total average cost increased substantially among patients with TKR or THR compared to those who did not undergo surgery (Table 3).

These findings have several important implications. First, they highlight the importance of public education to increase patients' awareness and knowledge about OA and means to efficiently prevent or slow progression of the disease. Once a joint replacement is inevitable, the economic burden to either society or patients becomes much greater. Second, the direct costs to patients in Singapore were substantially higher than costs reported in Hong Kong[2]. The Hong Kong government bore 68% of the total costs of those with mild OA. The percentage increased to 95% for those with joint surgery, while in Singapore the subsidy is generally around 50% regardless of presence or absence of joint surgery. Obviously, a flexible or "stepped" subsidy policy according to disease severity would offer real benefits to patients, especially those who are financially disadvantaged. This may provide an incentive for them to seek treatment earlier. Third, as treatment costs (excluding medicine according to the definition in this study) were the leading cost driver across all ethnic groups, it suggests that research priorities may go to advances in cost-effective treatments (e.g., surgery) in order to significantly reduce the healthcare expenditures of OA.

In this study the rate of joint surgery differed across ethnic groups. More than half of Chinese patients seen in hospital over the study period had undergone TKR or THR, which is significantly higher than for other ethnic groups. One possible explanation for the high rate may be that many Chinese patients seek medical treatment only when the condition is very severe (and normally a surgery is needed at that time), as they believe joint pain is a natural phenomenon of old age and seldom pay attention at the early stages of the condition. This may reflect a cultural influence in healthcare-seeking behavior among Chinese. Further, there

Table 4. Indirect costs of OA.

	Patients without Surgery				Patients with TKR/THR				
	Chinese, n = 59	Malay, n = 9	Indian, n = 12	Subtotal, n = 80	Chinese, n = 16	Malay, n = 6	Indian, n = 3	Subtotal, n = 25	Total, n = 105
Mean (SD) absence from work, days*	7.0 (3.5)	6.0 (0)	9.0 (7.1)	7.3 (3.8)	37.6 (34.9)	97.5 (116.7)	45.0 (21.2)	48.8 (50.8)	31.0 (43.2)
Mean (SD) productivity loss, % **	37.4 (13.7)	39.4 (18.6)	37.1 (16.6)	37.6 (14.6)	49.4 (25.9)	67.5 (9.9)	51.7 (41.9)	54.0 (25.4)	41.5 (19.0)
Mean (SD), indirect costs, $ †	1215 (450)	1138 (451)	1371 (525)	1230 (460)	3834 (3618)	6116 (9272)	5292 (2674)	4557 (5264)	2022 (2930)

* Mean days of absence from work were estimated for working patients. Among those without surgery, 6 Chinese, 1 Malay, and 2 Indians were working. Among those with TKR/THR, 8 Chinese, 2 Malays, and 2 Indians were working. ** Mean productivity loss estimated for nonworking patients. Among those without surgery, 53 Chinese, 8 Malays, and 10 Indians were retiree/homemakers. Among those with TKR/THR, 8 Chinese, 4 Malays, and 1 Indian were nonworking. † Indirect costs are expressed as mean costs per patient per annum, 2003 Singapore dollars. 1 US dollar = 1.7 Singapore dollar. TKR: total knee replacement; THR: total hip replacement.

also were some ethnic variations in specific healthcare resources consumed among those patients who had TKR or THR. The ethnic variations in utilization of health resources for OA have been reported in many other studies[24-33]. However, the implication of this difference in resource consumption among different ethnic groups is insufficiently evaluated in Asian communities and would need further exploration.

Comparing other countries, the costs of OA also varied substantially. Broadly speaking, the direct and indirect costs for those without surgery were comparable between Singapore and Hong Kong. However, the costs for those with surgery were significantly higher in Hong Kong[2]. Compared with several Western countries, the direct costs in Singapore were lower than in France[34], the USA[4,8], and Canada[35], but higher than in Italy[6]. Conversely, indirect costs in our study were lower than in Italy[6], but higher than those in the USA[23] and Canada[35]. There is an interesting phenomenon, that is, the richer a country in terms of gross domestic product per capita, the higher the direct costs for OA in that country.

Direct and indirect costs are 2 important components in cost of illness evaluation studies[17]. However, it remains debatable which imposes a heavier burden on patients. Several studies have shown that indirect costs were 3 times higher than direct costs and accounted for up to 80% of total costs in patients with OA[6,36]. In contrast, direct costs were higher than indirect costs in our study, consistent with some previous studies[2,23,35]. There are several possible explanations. First, the patients were younger in estimations of indirect costs than in estimations of direct costs. Second, a higher percentage of patients had undergone joint replacement surgery, which is the main cost driver. Third, the indirect costs related to home care for retirees or homemakers were not taken into consideration. Lastly, the majority of patients that contributed data for estimating indirect costs were retirees or homemakers. It should be noted that the differences between direct and indirect costs were more prominent across different ethnic groups when the patients had joint surgery, especially for Chinese patients.

One of the main limitations of our study is that the number of patients used in estimating indirect costs was small compared to those for estimating direct costs. Thus, we tended not to aggregate the 2 cost components to estimate an overall economic burden on patients, as done in some other studies[2,35,36]. As well, the indirect costs incurred by family members or caregivers to take care of the patients were not assessed, as most of the patients reported they could not recall such information at all. Thus, the magnitude of indirect costs estimated in this study could be considered at the lower end of the spectrum. Second, it may be argued that the participating patients from a tertiary referral hospital may not be fully representative of patients with OA in Singapore. However, due to the setup of the Singapore healthcare system, a significant proportion of OA patients normally managed by primary healthcare physicians would also be managed at the outpatient clinic of a tertiary hospital. Hence, our patient sample would be reasonably representative of OA patients from both primary and tertiary referral settings in Singapore. However, this may be atypical in other countries. Thus caution needs to be exercised when generalizing the results to other settings. Third, comorbidities are very common among patients with OA, who are normally older. Thus, the existence of comorbidities does influence the cost evaluation. However, it would be impractical to exclude patients with comorbidities as more than 50% would be excluded. Future studies should estimate the costs attributable to OA by recruiting both patients with OA and age and sex matched patients without OA.

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