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Impact of Osteoarthritis on Household Catastrophic Health Expenditures in Korea

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ABSTRACT

Background: Osteoarthritis (OA) is a disease of old age whose prevalence is increasing. This study explored the impact of OA on household catastrophic health expenditure (CHE) in Korea.

Methods: We used data on 5,200 households from the Korea Health Panel Survey in 2013 and estimated annual living expenses and out-of-pocket (OOP) payments. Household CHE was defined when a household's total OOP health payments exceeded 10%, 20%, 30%, or 40% of the household's capacity to pay. To compare the OOP payments of households with OA individuals and those without OA, OA households were matched 1:1 with households containing a member with other chronic disease such as neoplasm, hypertension, heart disease, cerebrovascular disease, diabetes, or osteoporosis. The impact of OA on CHE was determined by multivariable logistic analysis.

Results: A total of 1,289 households were included, and households with and without OA patients paid mean annual OOP payments of \$2,789 and \$2,607, respectively. The prevalence of household CHE at thresholds of 10%, 20%, 30%, and 40% were higher in households with OA patients than in those without OA patients ($P < 0.001$). The presence of OA patients in each household contributed significantly to CHE at thresholds of 10% (odds ratio [OR], 1.48; 95% confidence interval [CI], 1.16–1.87), 20% (OR, 1.29; 95% CI, 1.01–1.66), and 30% (OR, 1.37; 95% CI, 1.05–1.78), but not of 40% (OR, 1.17; 95% CI, 0.87–1.57).

Conclusion: The presence of OA patients in Korean households is significantly related to CHE. Policy makers should try to reduce OOP payments in households with OA patients.

Keywords: Osteoarthritis; Health Expenditure; Households

INTRODUCTION

Korea (officially the Republic of Korea) is the third youngest country in the Organization for Economic Co-operation and Development (OECD), but it is a rapidly aging country with regard to the average age of its inhabitants; in fact, it is expected to be the second oldest after Japan by 2050.¹ As the middle-aged population has been growing, chronic diseases are becoming more common. For example, osteoarthritis (OA) is an age-related disorder resulting in both direct and indirect medical costs²; its disease burden involves not only medical expenses for treatment itself, but also consequent loss of productivity.³

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Disclosure

The authors have no potential conflicts of interest to disclose.

Author Contributions

Conceptualization: Kim H, Cho SK, Sung YK.
Formal analysis: Kim D, Kim D, Jung SY, Jang EJ. Investigation: Kim H, Kim D. Methodology: Sung YK, Jang EJ. Writing - original draft: Kim H. Writing - review & editing: Cho SK, Sung YK.

According to the National Statistical Year Book of Korea for 2015, knee OA, as a single disease entity, was the fourth highest medical expense, costing approximately 6.9 billion dollars in the population aged over 65 years.⁴ The prevalence of OA in Korean adults over 50 is also growing; it was 13.0% in 2005 and grew to 14.3% in 2010, as estimated by the Korea National Health and Nutrition Examination Survey (KNHNES).^{5,6} There is a tendency for OA prevalence to increase with age, and OA is approximately five times more prevalent in those in their 70s than in those in their 50s, where there was a prevalence rate of 2.1% based on KNHNES from 2010 to 2013.⁷

There are several methods for estimating the economic burden of diseases. One, out-of-pocket (OOP) payments, refers to the direct payments by households after medical service use.⁸ Catastrophic health expenditure (CHE) is defined when a household's total OOP payments for health services equals or exceeds 40% of the household's non-subsistence spending capacity.⁸ This does not always mean high healthcare costs, because CHE depends on the extent of the individual's insurance coverage and the household income; even small costs for common illnesses can lead to impoverishment of poor households without medical insurance.⁹ Hence, protecting people from CHE is a crucial aim for health-policy makers.¹⁰

It is believed that OA increases medical expenditure, but a direct relationship between OA and CHEs has not been well studied. There are previous studies on the relationship between OA and economic cost, but these focused on the proportion of direct and indirect medical costs,^{11,12} or were limited to the economic effects on specific populations of a given gender.^{3,13} There have also been several studies of OA in Korea, but these were confined to prevalence, characteristics of patients, or risk factors in a specific region.^{14,15} We designed a study to assess the impact of OA on CHEs in Korea.

METHODS**Source of data**

We conducted a cross-sectional study based on the Korea Health Panel Survey (KHPS) of 2013. This survey has provided annual comprehensive information to the public since 2008, stratifying representative samples in proportion to population size.¹⁶ The survey consists of demographic and socio-economic characteristics at the individual and household level, providing associated health care expenditures by total income quintile. It also contains information on inpatient care, outpatient care, and emergency service use for chronic illness. We extracted data from 5,200 of the households surveyed by KHPS in 2013 and matched their information with the claims database to determine the prevalence of OA in those households.

Definition of variables*OOP payments*

OOP payments included all health-related costs that were paid for any medical service¹⁷ and those for any type of drug used in the in-patient or out-patient setting as well as the emergency department. Payments for extra services or reimbursements were excluded in estimating OOP payments.⁸

Household's capacities to pay

A household's capacity to pay was the household's total income minus subsistence costs and food costs.^{8,17} Although food expenditure excluded cost of food eaten outside the home,

there was no proper information about spending in restaurants in the KHPS. Thus, the total cost of food consumption was taken as food expenditure in this study.

Definition of CHE and its thresholds

CHE was defined by the World Health Organization (WHO) when direct health care costs exceeded 40% of a household's capacity to pay, and the threshold was adjusted for each country.¹⁸ The frequency of CHEs can vary depending on the level of threshold used,¹⁹ and there is controversy over the ideal threshold. Most researchers apply thresholds between 10% and 40%^{17,20-25}; we evaluated CHEs at 10%, 20%, 30%, and 40% thresholds.

Statistical analysis

The main determinant of this study was OA. Households were stratified into two groups by the presence of at least one family member with OA, which was defined following the diagnostic code from M15.0 to M19.0 of the International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10) and the Korean Classification of Disease, 6th revision (KCD-6). Each household with OA patients was matched one-to-one with a household without an OA patient, depending on the presence of a family member suffering from a neoplasm, hypertension, heart disease, cerebrovascular disease, diabetes, or osteoporosis. These disease entities are generally related to high medical costs in Korea.²⁶ Demographic characteristics included sex, age, economic status, and employment status. The presence of householders' spouses, education levels of householders, and types of health insurance were also considered. The distribution of CHEs were evaluated at each threshold level, and the χ^2 test was used to assess statistical significance. Multivariable logistic regression models were used to identify the impact of the presence of OA patients among family members on the development of CHE according to cut-off values of 10%, 20%, 30%, and 40%. These models were used after adjusting for the following parameters at baseline: age, sex, education level of householder, employment status of householder, number of household members with comorbidities, and healthcare utilization (such as insurance type and private health insurance). All analyses were performed using SAS 9.2 (SAS Institute, Cary, NC, USA). *P*value less than 0.05 was considered statistically significant.

Ethics statement

The Institutional Review Board (IRB) of Hanyang University Hospital determined that this study was exempt from IRB review because we used existing, publicly available data and the information about the subjects could not be identified directly or through identifiers linked to the subjects (IRB file No. HYUH 2017-06-005). Informed consent was waived by the IRB.

RESULTS

Baseline characteristics

A total of 1,457 households with OA patients and 3,743 households without OA patients were identified, and 1,289 households in each group were matched by adjusting the presence of comorbidities other than OA. The general characteristics of the matched households are shown in **Table 1**.

All households with OA patients had family members with at least one comorbidity, compared to 63 (4.9%) households without OA patients who had no comorbidities at all. The size of the household was not significantly different between households with OA patients and those without OA patients.

Table 1. Baseline characteristics of households with or without OA patients

Variables	Households with OA patients (n = 1,289)	Households without OA patients (n = 1,289)	P
Sex of householder			< 0.001
Male	894 (69.4)	1,048 (81.3)	
Female	395 (30.6)	241 (18.7)	
Age of householder, yr			< 0.001
20–39	2 (0.2)	69 (5.4)	
40–59	235 (18.2)	502 (38.9)	
60–79	1,052 (81.6)	718 (55.7)	
Presence of householder's spouse			< 0.001
Yes	848 (65.9)	970 (75.5)	
No	439 (34.1)	315 (24.5)	
Educational level of householder			< 0.001
Elementary school	589 (45.7)	302 (23.4)	
Middle school	240 (18.6)	198 (15.4)	
High school	324 (25.1)	418 (32.4)	
College or above	136 (10.6)	371 (28.8)	
Employment status of householder			< 0.001
Regular employee	104 (8.1)	294 (22.8)	
Temporary employee	189 (14.7)	245 (19.0)	
Employer or owner	390 (30.3)	328 (25.5)	
Unpaid family worker	3 (0.2)	7 (0.5)	
Missing	603 (46.8)	415 (32.2)	
Economic level ^a of householder			< 0.001
Level 1 (poorest, 0%–20%)	461 (35.8)	257 (19.9)	
Level 2 (20%–40%)	327 (25.4)	259 (20.1)	
Level 3 (40%–60%)	220 (17.1)	259 (20.1)	
Level 4 (60%–80%)	153 (11.9)	259 (20.1)	
Level 5 (richest, 80%–100%)	128 (9.9)	255 (19.8)	
No. of household members			< 0.001
One	304 (23.6)	209 (16.2)	
Two	559 (43.4)	413 (32.0)	
Three	206 (16.0)	232 (18.0)	
Four	102 (7.9)	306 (23.7)	
≥ Five	118 (9.2)	129 (10.0)	
No. of household members with comorbidities			< 0.001
None	0 (0.0)	63 (4.9)	
One	449 (34.8)	446 (34.6)	
Two	671 (52.1)	590 (45.8)	
Three	123 (9.5)	135 (10.5)	
Four	26 (2.0)	46 (3.6)	
≥ Five	20 (1.6)	9 (0.7)	
Type of medical insurance			0.084
National health insurance	1,183 (91.8)	1,208 (93.7)	
Medicaid	104 (8.1)	77 (6.0)	
None	2 (0.2)	4 (0.3)	
Having private health insurance			< 0.001
Yes	784 (60.8)	1,000 (77.6)	
No	505 (39.2)	289 (22.4)	

Values are presented as number (%).

OA = osteoarthritis.

^aAll participants were divided into five groups and ordered from lowest (level 1 as bottom 20%) to highest (level 5 as top 20%) in order of household income.

OOP expenditure in households with and without OA

As shown in **Table 2**, the annual capacities to pay for households with and without OA patients were \$14,166 and \$19,865, respectively ($P < 0.001$). However, households with OA patients tended to pay higher annual OOP costs (\$2,789) than households without OA patients (\$2,607). The OOP payments of households with OA patients went significantly more on the purchase of prescriptions or over-the-counter drugs than on hospitalization.

Table 2. Annual OOP healthcare payments and capacity to pay of households with or without OA patients (1:1 matched)

Variables	Households with OA patients (n = 1,289)		Households without OA patients (n = 1,289)		Ratio ^b	P
	Mean ± SD	Median (Q1, Q3)	Mean ± SD	Median (Q1, Q3)		
Total OOP healthcare payments ^a	2,789 ± 3,270	1,719 (782, 3,580)	2,607 ± 3,207	1,671 (692, 3,335)	1.07	0.155
Emergency department	16 ± 60	0 (0, 0)	16 ± 64	0 (0, 0)	0.98	0.877
Hospitalization	545 ± 1,475	0 (0, 300)	484 ± 1,832	0 (0, 81)	1.13	0.353
Outpatient clinic	891 ± 1,206	470 (183, 1,096)	913 ± 1,360	465 (169, 1,090)	0.98	0.664
Prescription drugs	314 ± 306	241 (112, 431)	281 ± 283	200 (78, 386)	1.12	0.004
Over-the-counter drugs	734 ± 1,527	204 (0, 720)	615 ± 1,246	214 (0, 672)	1.19	0.030
Herbal medications ^c	289 ± 1,586	0 (0, 0)	299 ± 1,521	0 (0, 0)	0.97	0.876
Health supplements ^d	737 ± 5,026	0 (0, 0)	957 ± 3,865	0 (0, 0)	0.77	0.212
Household's capacity to pay	14,166 ± 12,962	9,600 (5,400, 18,000)	19,865 ± 15,095	16,785 (8,160, 27,600)	0.71	< 0.001

OOP = out-of-pocket, OA = osteoarthritis, SD = standard deviation.

^aPresented in United States dollars (USDs) at the exchange rate of 1,000 won (KRW) per 1 USD; ^bRatio of mean costs of households with OA patients to those without OA patients were noted; ^cHerbal medications including total purchase of herbal medications in pharmacies, herbal medicine shops, and oriental medical clinics; ^dHealth supplements are products used to supplement the diet, purchased in a pharmacy, hypermarket, or by internet.

Table 3. Frequencies of CHEs at each threshold level

Threshold level ^a (%)	Households with OA patients	Households without OA patients	P
10	854 (66.3)	657 (51.0)	< 0.001
20	567 (44.0)	362 (28.1)	< 0.001
30	397 (30.8)	236 (18.3)	< 0.001
40	298 (23.1)	175 (13.6)	< 0.001

Values are presented as number (%).

CHE = catastrophic health expenditure, OA = osteoarthritis.

^aThreshold level means direct health care costs divided by household's capacity to pay; CHE was defined when direct health care costs exceeded, variously, 10%, 20%, 30%, or 40% of a household's capacity to pay.

Prevalence of CHEs in households with and without OA

Of the households with OA patients, 66.3%, 44.0%, 30.8%, and 23.1%, were found to have CHEs at thresholds of 10%, 20%, 30%, and 40%, respectively ($P < 0.001$, **Table 3**). CHE in households without OA patients was less frequent: 51%, 28.1%, 18.3%, and 13.6% at the 10%, 20%, 30%, and 40% thresholds, respectively.

OA as a risk factor for CHE

Several factors were associated with the occurrence of CHE as assessed in the multivariable regressions (**Table 4**). The presence of OA patients in each household was significantly related to CHEs at thresholds from 10% to 30%: 10% (odds ratio [OR], 1.48; 95% confidence interval [CI], 1.16–1.87), 20% (OR, 1.29; 95% CI, 1.01–1.66), and 30% (OR, 1.37; 95% CI, 1.05–1.78). However, OA was not a definite determinant that affected CHE at the 40% threshold (OR, 1.17; 95% CI, 0.87–1.57).

Also, households in higher quintiles of income were less likely to experience CHEs at thresholds of 10% and 20%. In fact, households in which the householder was highly educated rarely encountered CHEs at the 10% and 20% thresholds. However, there were no definite associations between other variables and the occurrence of CHE.

DISCUSSION

In this study, we compared households with OA patients to those without OA patients with regard to CHE. The households with OA patients experienced CHE more frequently at all thresholds, and this was associated with both increased OOP payments and lower

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Table 4. Factors associated with the occurrence of CHEs at each threshold level

Variables ^a	10%	20%	30%	40%
Having more than one member with OA				
No			Reference	
Yes	1.48 ^c (1.16–1.87)	1.29 ^b (1.01–1.66)	1.37 ^b (1.05–1.78)	1.17 (0.87–1.57)
Sex of householder				
Male			Reference	
Female	0.63 (0.34–1.16)	1.50 (0.79–2.85)	1.40 (0.67–2.90)	1.80 (0.74–4.35)
Age of householder, yr				
20–39			Reference	
40–59	1.15 (0.37–3.54)	2.57 (0.56–11.92)	1.22 (0.21–7.21)	1.58 (0.20–12.64)
60–79	1.59 (0.49–5.18)	3.72 (0.79–17.55)	2.12 (0.36–12.46)	3.20 (0.41–24.68)
Presence of householder's spouse				
No			Reference	
Yes	0.91 (0.49–1.66)	1.19 (0.61–2.29)	0.78 (0.36–1.68)	1.66 (0.65–4.20)
Educational level of householder				
Elementary school			Reference	
Middle school	1.12 (0.70–1.79)	0.97 (0.61–1.55)	1.49 (0.88–2.51)	1.41 (0.80–2.48)
High school	0.84 (0.53–1.32)	0.76 (0.48–1.22)	0.92 (0.55–1.54)	0.93 (0.53–1.63)
College or above	0.50 ^b (0.29–0.86)	0.53 ^b (0.29–0.96)	0.62 (0.32–1.19)	0.54 (0.25–1.16)
Employment status of householder				
Regular employee			Reference	
Temporary employee	0.84 (0.47–1.50)	1.26 (0.66–2.40)	1.20 (0.53–2.73)	1.37 (0.52–3.61)
Employer or owner	0.68 (0.40–1.16)	0.90 (0.48–1.67)	0.84 (0.38–1.85)	0.92 (0.37–2.30)
Unpaid family worker	0.99 (0.57–1.73)	1.05 (0.57–1.95)	1.63 (0.75–3.52)	1.71 (0.69–4.22)
Unemployed	0.78 (0.42–1.44)	0.79 (0.41–1.51)	0.98 (0.45–2.13)	0.83 (0.35–1.98)
Economic level of household				
Level 1 (poorest, 0%–20%)			Reference	
Level 2 (20%–40%)	0.57 ^b (0.34–0.93)	0.49 ^c (0.30–0.79)	0.43 ^c (0.26–0.72)	0.37 ^d (0.21–0.65)
Level 3 (40%–60%)	0.34 ^d (0.20–0.57)	0.27 ^d (0.16–0.47)	0.27 ^d (0.15–0.50)	0.25 ^d (0.12–0.50)
Level 4 (60%–80%)	0.31 ^d (0.18–0.56)	0.19 ^d (0.10–0.36)	0.23 ^d (0.11–0.48)	0.13 ^d (0.05–0.32)
Level 5 (richest, 80%–100%)	0.15 ^d (0.08–0.29)	0.11 ^d (0.05–0.23)	0.17 ^d (0.07–0.39)	0.23 ^d (0.10–0.54)
No. of household members				
One			Reference	
Two	0.60 (0.31–1.17)	0.63 (0.31–1.26)	0.69 (0.31–1.55)	0.75 (0.30–1.90)
Three	0.59 (0.27–1.29)	0.73 (0.31–1.73)	0.77 (0.27–2.20)	0.47 (0.14–1.59)
Four	0.37 ^b (0.15–0.87)	0.30 ^b (0.11–0.82)	0.47 (0.16–1.43)	0.28 (0.08–1.03)
≥ Five	0.25 ^d (0.13–0.47)	0.48 ^b (0.27–0.86)	0.53 (0.27–1.02)	0.77 (0.39–1.55)
No. of household members with comorbidities				
None			Reference	
One	1.91 (0.49–7.54)	0.62 (0.14–2.85)	0.97 (0.15–6.26)	0.54 (0.08–3.58)
Two	2.95 (0.71–12.21)	0.56 (0.12–2.72)	0.64 (0.10–4.33)	0.38 (0.05–2.64)
Three	7.18 ^b (1.55–33.29)	0.24 (0.03–2.28)	0.62 (0.06–7.05)	0.81 (0.06–11.31)
≥ Four	2.08 (0.25–17.03)	1.76 (0.19–16.33)	1.43 (0.09–21.82)	3.65 (0.17–78.22)
Type of medical insurance				
National health insurance			Reference	
Medicaid	0.94 (0.64–1.37)	1.02 (0.68–1.53)	1.16 (0.73–1.82)	1.42 (0.88–2.30)
Having private health insurance				
No			Reference	
Yes	1.50 (0.40–5.57)	0.33 (0.08–1.47)	0.39 (0.06–2.33)	0.27 (0.04–1.71)

Values are presented as OR (95% CI).

CHE = catastrophic health expenditure, OA = osteoarthritis, OR = odds ratio, CI = confidence interval.

^aAdjusted for comorbidities other than OA; ^bP < 0.05; ^cP < 0.01; ^dP < 0.001.

household capacities to pay. The OOP costs of hospitalization and drug use were higher in the households with OA patients than in those without OA patients.

CHEs are determined by the number of family members, their average age, the total family income, the family members' employments, their educational levels, and their health insurance coverage.²⁷ These are not only individual factors, but also social factors that can

be influenced by a nation's policy. OOP medical costs can result in increased expenditure that reduces quality of life and promotes a transition to poverty.^{28,29} Thus, CHEs have been considered in terms of the catastrophic impact of OOP payments at the household and national levels.^{19,24,30} CHE is considered to reflect the extent of medical coverage and financial support given by the nation. Studies of CHEs have been conducted at different thresholds up to 40%, and CHEs could vary by definition of the threshold. The optimal threshold should depend on the society under consideration.¹⁸

There have been several attempts to discuss CHEs and their determinants in the context of the characteristics of the insurance system or change in insurance systems of a given country. Several studies focused on specific chronic diseases within a population exposed to CHE in respect of economic influence on society; occurrence of CHEs in patients having certain malignancies have been explored,^{31,32} or interval change of CHEs in rheumatoid arthritis patients have been noted since biologic disease-modifying antirheumatic drugs (DMARDs) were introduced.³³⁻³⁵ However, the relationship between OA and CHEs had not been clearly evaluated. A cohort study in Hong Kong found that OA contributed more to direct medical costs than in the West; in the former, direct medical costs excluding joint replacements ranged from Hong Kong dollars \$11,690 to \$40,180 per person per year.³⁶

To build upon these previous results, we aimed to evaluate the relationship between CHE and another common illness, OA, in the general population. We observed that CHE was common in households with family members with OA. OA contributes to increased medical costs; in the United States, OA made the second largest contribution to medical costs, and 4.3% of all hospitalization-related costs were due to OA.³⁷ Also, adult patients with non-rheumatic arthritis in the US had additional medical costs of \$2,117 annually.³⁸ In Singapore, the economic burden of OA increased 3-fold or more in patients who underwent total knee or hip replacement compared to a burden of \$1,459 in those who did not undergo surgery.³⁷

OA is a chronic disease that increases in prevalence with age, but the old also tend to have other chronic diseases. These can be confounding factors that lead to additional medical expenses. In our study, to minimize the unexpected influence of other illnesses on medical cost, OA households were paired with others having similar comorbidities including neoplasms, hypertension, heart disease, cerebrovascular disease, diabetes, or osteoporosis. Since having family members with chronic diseases also had a potent influence on CHE, we used multivariable regression models in our analysis.

The presence of OA patients in Korean households was significantly related to CHE at thresholds of 10%, 20%, and 30%, but not 40%. Korean national medical insurance and medicaid cover over 95% of the population; therefore, the 40% threshold is too high to be generalized to many other nations. OOP expenditure exceeding 40% of a family's total income is rare, and thresholds less than 30% are unusual in societies that have similar public health policies. From this point of view, OA was a definite independent factor contributing to CHE in Korean households even though its significance is only evident at thresholds up to 30%.

In addition, a low educational level of the head of household, and the presence of four household members with comorbidities contributed to the occurrence of CHEs at all thresholds. Householders themselves might be OA patients, in which case they would not be able to have highly productive occupations due to the physical limitations imposed by OA.

Higher household economic level and number of household members did not influence CHE at any threshold level. These are socioeconomic factors that influence each other, and result in relatively little expenditure compared to total incomes.

OA contributed to several aspects of the occurrence of CHE. Households including OA patients tended to be in the lower income quantile and thus had a lower capacity to pay. Households with OA patients also made more OOP payments related to drug use and hospitalization than to attendance in outpatient clinic or emergency departments. On the other hand, it was clear that these households had a lower capacity to pay. This indicates that they also include a higher number of patients with comorbid conditions, even though we matched the two groups in terms of other comorbidities.

In general, Koreans tend to avoid surgical treatment because of a desire to use their own joints for as long as possible. Koreans have higher copayments than patients in other countries with comparable incomes due to non- or partial coverage of certain treatments.³⁹ This might be a barrier to economically vulnerable patients being able to access medical facilities and could lead to significant extra expenditure on drugs.

This study supporting a close relationship between OA and CHE has several strengths. First, the data were based on panel surveys and national statistical data, which contain a wide range of variables. These two data sets were linked, while previous studies on CHE were solely based on surveys. Second, this study was optimized by adjusting each household for comorbidities other than OA, and confounding bias that might influence the interpretation of CHEs was minimized. Finally, we evaluated CHE at various thresholds so that the results could be compared with those obtained in other countries with similar medical insurance systems.

However, there were also potential limitations to this study. We defined OA using only diagnostic codes; thus, there was a possibility of overestimating the prevalence of OA patients in the households. This could have reduced the difference in OOP payments between households with and without OA patients. However, the diagnostic code itself was meaningful because it was selected based on the clinical judgement of physicians and symptoms reported by the patients themselves, and included not only radiologic but also symptomatic OA patients. Thus, any procedure or medication prescribed with the OA diagnostic code could be regarded as a reflection of the actual amount of medical expenses related to OA. The database lacked clinical information about the lesions involved and the severity of OA in each patient. This was because the Korean insurance system does not require specific diagnostic codes further specifying the attributes of OA.

If we had been able to set a threshold to knee or hip OA in the analysis, OA might have had more effect on CHE. Also, there could have been recall bias in the survey related to the use of health supplements or over-the-counter drugs, and this could have led to overestimating the magnitude of the influence on CHE. Nevertheless, this study makes a meaningful contribution to estimation of the impact of total OA, regardless of the parts affected, on CHE among.

In conclusion, we have shown that OA has a significant impact on the occurrence of CHE. OA is not just a problem for the individual, but a crucial factor affecting the economic burden on a household. Policy makers should consider the economic burden of OA in the real world and investigate how to reduce extra medical costs incurred by OA patients under the current health care system.

REFERENCES

1. Harper S. Economic and social implications of aging societies. *Science* 2014;346(6209):587-91.
[PUBMED](#) | [CROSSREF](#)
2. Shane Anderson A, Loeser RF. Why is osteoarthritis an age-related disease? *Best Pract Res Clin Rheumatol* 2010;24(1):15-26.
[PUBMED](#) | [CROSSREF](#)
3. Gupta S, Hawker GA, Laporte A, Croxford R, Coyte PC. The economic burden of disabling hip and knee osteoarthritis (OA) from the perspective of individuals living with this condition. *Rheumatology (Oxford)* 2005;44(12):1531-7.
[PUBMED](#) | [CROSSREF](#)
4. Health Insurance Review & Assessment Service. National Health Insurance Statistical Year Book. <http://opendata.hira.or.kr/op/opc/selectStcPblc.do?sno=11201&odPblcTpCd=002&searchCnd=&searchWrd=&pageIndex=1>. Updated 2015. Accessed on August 6, 2017
5. Shin DW, Nam S, Bang YS, Lee JY. Estimation of the prevalence of Korean adults aged 50 years or more with knee osteoarthritis based on the data from fifth Korea National Health and Nutrition Examination Survey. *J Korean Med Assoc* 2013;56(5):431-6.
[CROSSREF](#)
6. Hur NW, Choi CB, Uhm WS, Bae SC. The prevalence and trend of arthritis in Korea: results from Korea National Health and Nutrition Examination Surveys. *J Korean Rheum Assoc* 2008;15(1):11-26.
[CROSSREF](#)
7. KCDC. Prevalence of Osteoarthritis among Adults over 50 years old in Korea, 2010–2013. <http://cdc.go.kr/CDC/info/CdcKrInfo0301.jsp?menuIds=HOME001-MNU1154-MNU0005-MNU0037&cid=61436>. Updated 2015. Accessed on August 6, 2017.
8. Xu K. Distribution of health payments and catastrophic expenditures Methodology. <http://www.who.int/iris/handle/10665/69030>. Updated 2005. Accessed on August 6, 2017.
9. Puteh SE, Almuallm Y. Catastrophic health expenditure among developing countries. *Health Syst Policy Res* 2017;4:1.
[CROSSREF](#)
10. Filmer D, Hammer JS, Pritchett LH. Weak links in the chain II: a prescription for health policy in poor countries. *World Bank Res Obs* 2002;17(1):47-66.
[CROSSREF](#)
11. Chen A, Gupte C, Akhtar K, Smith P, Cobb J. The global economic cost of osteoarthritis: how the UK compares. *Arthritis* 2012;2012:698709.
12. Bitton R. The economic burden of osteoarthritis. *Am J Manag Care* 2009;15(8 Suppl):S230-5.
[PUBMED](#)
13. Kotlarz H, Gunnarsson CL, Fang H, Rizzo JA. Insurer and out-of-pocket costs of osteoarthritis in the US: evidence from national survey data. *Arthritis Rheum* 2009;60(12):3546-53.
[PUBMED](#) | [CROSSREF](#)
14. Cho NH, Kim SH, Kim HA, Seo YI. The prevalence and risk factors of knee and hand osteoarthritis in Korea. *J Korean Rheum Assoc* 2007;14(4):354-62.
[CROSSREF](#)
15. Choi HJ, Han WJ, Im JS, Baek HJ. The prevalence and clinical features of musculoskeletal diseases in Incheon: results from chronic disease management surveys. *J Korean Rheum Assoc* 2009;16(4):281-90.
[CROSSREF](#)
16. Korea Health Panel. Introduction of KHP. <https://www.khp.re.kr:444/eng/introduction/introduction.do>. Accessed on August 6, 2017.
17. Xu K, Evans DB, Kawabata K, Zeramdini R, Klavus J, Murray CJ. Household catastrophic health expenditure: a multicountry analysis. *Lancet* 2003;362(9378):111-7.
[PUBMED](#) | [CROSSREF](#)
18. Weraphong J, Pannarunothai S, Luxananun T, Junsri N, Deesawatsripetch S. Catastrophic health expenditure in an urban city: seven years after universal coverage policy in Thailand. *Southeast Asian J Trop Med Public Health* 2013;44(1):124-36.
[PUBMED](#)
19. Chuma J, Maina T. Catastrophic health care spending and impoverishment in Kenya. *BMC Health Serv Res* 2012;12:413.
[PUBMED](#) | [CROSSREF](#)

20. Berki SE. A look at catastrophic medical expenses and the poor. *Health Aff (Millwood)* 1986;5(4):138-45.
[PUBMED](#) | [CROSSREF](#)
21. Ranson MK. Reduction of catastrophic health care expenditures by a community-based health insurance scheme in Gujarat, India: current experiences and challenges. *Bull World Health Organ* 2002;80(8):613-21.
[PUBMED](#)
22. Devadasan N, Criel B, Van Damme W, Ranson K, Van der Stuyft P. Indian community health insurance schemes provide partial protection against catastrophic health expenditure. *BMC Health Serv Res* 2007;7:43.
[PUBMED](#) | [CROSSREF](#)
23. Knaul FM, Arreola-Ornelas H, Méndez-Carniado O, Bryson-Cahn C, Barofsky J, Maguire R, et al. Evidence is good for your health system: policy reform to remedy catastrophic and impoverishing health spending in Mexico. *Lancet* 2006;368(9549):1828-41.
[PUBMED](#) | [CROSSREF](#)
24. Kronenberg C, Barros PP. Catastrophic healthcare expenditure - drivers and protection: the Portuguese case. *Health Policy* 2014;115(1):44-51.
[PUBMED](#) | [CROSSREF](#)
25. Rahman MM, Gilmour S, Saito E, Sultana P, Shibuya K. Health-related financial catastrophe, inequality and chronic illness in Bangladesh. *PLoS One* 2013;8(2):e56873.
[PUBMED](#) | [CROSSREF](#)
26. Health service delivery profile: Republic of Korea. http://www.wpro.who.int/health_services/service_delivery_profile_republic_of_korea.pdf. Updated 2012. Accessed on August 8, 2017.
27. Li Y, Wu Q, Xu L, Legge D, Hao Y, Gao L, et al. Factors affecting catastrophic health expenditure and impoverishment from medical expenses in China: policy implications of universal health insurance. *Bull World Health Organ* 2012;90(9):664-71.
[PUBMED](#) | [CROSSREF](#)
28. Jiang C, Ma J, Zhang X, Luo W. Measuring financial protection for health in families with chronic conditions in Rural China. *BMC Public Health* 2012;12:988.
[PUBMED](#) | [CROSSREF](#)
29. Lee JE, Shin HI, Do YK, Yang EJ. Catastrophic health expenditures for households with disabled members: evidence from the Korean health panel. *J Korean Med Sci* 2016;31(3):336-44.
[PUBMED](#) | [CROSSREF](#)
30. Amaya Lara JL, Ruiz Gomez F. Determining factors of catastrophic health spending in Bogota, Colombia. *Int J Health Care Finance Econ* 2011;11(2):83-100.
[PUBMED](#) | [CROSSREF](#)
31. The ACTION Study Group. Catastrophic health expenditure and 12-month mortality associated with cancer in Southeast Asia: results from a longitudinal study in eight countries. *BMC Med* 2015;13:190.
[PUBMED](#) | [CROSSREF](#)
32. O'Neill KM, Mandigo M, Pyda J, Nazaire Y, Greenberg SL, Gillies R, et al. Out-of-pocket expenses incurred by patients obtaining free breast cancer care in Haiti. *Lancet* 2015;385 Suppl 2:S48.
[PUBMED](#) | [CROSSREF](#)
33. Yazdany J, Dudley RA, Chen R, Lin GA, Tseng CW. Coverage for high-cost specialty drugs for rheumatoid arthritis in Medicare Part D. *Arthritis Rheumatol* 2015;67(6):1474-80.
[PUBMED](#) | [CROSSREF](#)
34. Lang HC, Lee HC, Lee SS, Lin HY, Chiu YM. The impact of introducing biologics to patients with rheumatoid arthritis in Taiwan: a population-based trend study. *Int J Rheum Dis* 2016;19(11):1112-8.
[PUBMED](#) | [CROSSREF](#)
35. Hopson S, Saverno K, Liu LZ, AL-Sabbagh A, Orazem J, Costantino ME, et al. Impact of out-of-pocket costs on prescription fills among new initiators of biologic therapies for rheumatoid arthritis. *J Manag Care Spec Pharm* 2016;22(2):122-30.
[PUBMED](#) | [CROSSREF](#)
36. Woo J, Lau E, Lau CS, Lee P, Zhang J, Kwok T, et al. Socioeconomic impact of osteoarthritis in Hong Kong: utilization of health and social services, and direct and indirect costs. *Arthritis Rheum* 2003;49(4):526-34.
[PUBMED](#) | [CROSSREF](#)
37. Murphy LB, Cisternas MG, Pasta DJ, Helmick CG, Yelin EH. Medical expenditures and earnings losses among US adults with arthritis in 2013. *Arthritis Care Res (Hoboken)*. 2017 Forthcoming.
[PUBMED](#) | [CROSSREF](#)

38. Torio CM, Moore BJ. National inpatient hospital costs: the most expensive conditions by payer, 2013: statistical brief #204. In: *Healthcare Cost and Utilization Project (HCUP) Statistical Briefs*. Rockville, MD: Agency for Healthcare Research and Quality; 2006–2016.
39. van Doorslaer E, O'Donnell O, Rannan-Eliya RP, Somanathan A, Adhikari SR, Garg CC, et al. Catastrophic payments for health care in Asia. *Health Econ* 2007;16(11):1159-84.
[PUBMED](#) | [CROSSREF](#)