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■ Original Article

Osteoarthritis Affects Health-Related Quality of Life in Korean Adults with Chronic Diseases: The Korea National Health and Nutritional Examination Surveys 2009–2013

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Background: Osteoarthritis (OA) is a chronic disease that commonly afflicts the elderly. This disease reduces the health-related quality of life (HRQoL) and causes a significant social burden. Whether the effect of coexisting chronic conditions on HRQoL varies according to the presence of OA remains unclear. Therefore, this study aimed to investigate this notion.

Methods: A total of 13,395 participants were identified from the 2009–2013 Korean National Health and Nutrition Examination Survey for analysis. HRQoL was assessed using the European quality of life-5 dimensions (EQ-5D) index. Patients with OA were defined as those diagnosed by a physician or those who displayed both, symptoms and radiological findings consistent with OA at the time of the survey. Associations between OA and 8 chronic conditions were tested using regression analysis.

Results: The EQ-5D index was lower in patients with OA than in those without (mean difference, -0.145; 95% confidence interval [CI], -0.138 to -0.151; P<0.001). Most patients with OA and chronic conditions showed a lower score than those without. EQ-5D was particularly lower in OA patients with hypertension, dyslipidemia, stroke, and renal failure. The estimated β coefficient for the interaction term was significant in renal failure (-0.034; 95% CI, -0.055 to -0.012), after adjusting for demographic and socio-economic variables.

Conclusion: OA significantly affects HRQoL of Korean elderly individuals alone or when combined with other conditions. OA combined with renal failure is particularly detrimental. These results indicate the importance of managing OA, which is an underestimated disease in public health surveys.

Keywords: Osteoarthritis; Chronic Disease; Quality of Life; Comorbidity

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INTRODUCTION

Individuals aged 65 years or older comprise 7.2% of the total population of Korea; their proportion is expected to increase to 14% by 2018.[1] Osteoarthritis (OA) is a common age-related chronic disease that affects 10.7% of the entire population; its prevalence increases with age, afflicting 17.1%, 27.3%, 31.5%, and 34.5% of those in their 50s, 60s, 70s, and 80s, respectively.[2]

OA causes pain and physical disabilities. It has been shown to be a leading cause of long-term physical and mental health problems in the elderly, thus reducing the health-related quality of life (HRQoL).[3-5] Costs for treating OA in Korea have reached 2,142 billion won annually, significantly increasing the social burden.[6] In terms of cost of medical management, OA is the second highest following hypertension.[6]

As a population ages, the number of patients with chronic comorbidities increases; 40%–56% of the Korean population aged 65 years or older was found to have chronic multimorbidities.[7,8] Such multiple chronic conditions are associated to a reduced HRQoL, including increased hospitalization, re-hospitalization, and mortality.[9] A study showed that the quality of life of OA patients decreases in most cases when accompanied by other chronic diseases; this suggests an additive relationship.[10]

Treatment of OA requires continued management, as it is often not curable. However, patients with OA often do not seek appropriate treatment, as they consider pain and stiffness of the musculoskeletal system to be consequences of aging, not symptoms of a disease.[11]

Studies on OA in Korea to date have mostly focused on its prevalence and risk factors. A few studies have investigated the effect of OA on the deterioration of the quality of life in patients with multimorbid chronic conditions. Therefore, this study aimed to investigate the effect of OA on HRQoL in Korean elderly individuals using data from the Korean National Health and Nutrition Examination Survey (KNHNES). The study also sought to provide evidence regarding the importance of managing OA, which is an underestimated disease, by examining whether patients with chronic conditions experience additional adverse effects because of the presence of OA.

METHODS

1. Subjects

This study was exempted from review by the Institutional Review Board of Seoul National University Bundang Hospital (IRB No. X-1602-333-901).

The KNHNES, conducted by the Korea Centers for Disease Control and Prevention, is a nationwide survey to collect data on health, perform medical examinations, and assess nutrition among population groups that represent the entire Korean population. This study used data from 44,085 individuals who participated in the KNHNES between 2009 and 2013.

In the KNHNES population, OA-diagnosing radiography on the hip and knee joints was performed for those 50 years or older. Therefore, subjects under 50 years of age or those who did not respond to the health interview survey were excluded from this study. A total of 13,395 participants were finally included.

2. Variables

1) Definition of Osteoarthritis

KNHNES defines the prevalence of OA as the presence of both pain and a Kellgren–Lawrence radiographic grade ≥2 in the knee or hip joint. The Kellgren–Lawrence grading system[12] divides OA into 5 grades: 0 (none), 1 (doubtful), 2 (minimal), 3 (moderate), and 4 (severe). Grades 0 and 2 indicate a definite absence of radiographic evidence of OA and the presence of OA albeit of minimal severity, respectively. Skilled radiologists performed radiologic assessments; radiography was conducted using the DigiRAD-PG 9M (Sitec Medical Co., Kimpo, Korea) and DICOM protocols. The presence of pain was assessed by responses to the question "Have you had pain in your knee or hip joint for more than 30 days during the past 3 months?"; participants who answered "yes" were considered to have joint pain.

Patients with OA also included those who reported having been diagnosed with OA by a physician in their health interview, as well as those who were determined to have OA based on their responses to other interviews conducted for the KNHNES.

2) Socio-demographic factors

Socio-demographic variables included age, sex, smoking status, household income, education level, household type, area of residence, occupation, health insurance type, and existence of private insurance. Ages were divided into groups of 50–59, 60–69, 70–79, and 80 years or older. The areas of residence were categorized as urban and rural. Household type was classified as living alone versus living with a family. Education level was divided into middle school or lower versus high school or higher. Income level was categorized into below medium-high versus above medium-high based on the monthly household income. Health insurance types included regional medical insurance/business, benefit class 1/2, and none. Occupation was categorized as white collar, blue collar, and none. Smoking statuses included current smoker, past smoker, and never smoker.

3) Comorbidity

Diagnoses of asthma, depression, stroke, myocardial infarction, or ischemic heart disease were based on the responses to the KNHNES questionnaire. Asthma and depression were recorded if they afflicted the participants at the time of the interview. Stroke, myocardial infarction, and ischemic heart disease were based on historical medical diagnoses. Patients with hypertension were defined as those who were previously diagnosed by a physician or were diagnosed at the time of the examination survey. Blood pressure was measured thrice in participants' right arms in a seated position after at least 5 minutes of rest, and the final blood pressure was the average of the second and third measurements. A mercury sphygmomanometer (Baumanometer;

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Table 1. General characteristics of study participants and EQ-5D index scores according to OA prevalence and chronic health conditions

Characteristic	Weighted EQ-5D index score				P-value
	Participants without OA		Participants with OA		
	N	Mean±SD	N	Mean±SD	
Age groups (y)					<0.001
50–59	4,486	0.95±0.082	404	0.858±0.134	
60–69	3,613	0.921±0.132	823	0.798±0.201	
70–79	2,386	0.879±0.188	964	0.734±0.24	
≥80	457	0.812±0.243	262	0.697±0.257	
Sex					<0.001
Men	5,104	0.941±0.11	484	0.816±0.19	
Women	5,838	0.909±0.14	1,969	0.768±0.221	
Household income (%)					<0.001
≤50	5,961	0.899±0.154	1,780	0.753±0.228	
>50	4,981	0.953±0.085	673	0.834±0.172	
Education					<0.001
≤Middle school	6,687	0.903±0.146	2,173	0.762±0.221	
≥High school	4,255	0.957±0.082	280	0.885±0.135	
Occupation					<0.001
White collar	2,123	0.961±0.066	211	0.865±0.146	
Blue collar	3,683	0.942±0.097	729	0.812±0.167	
Unemployed	5,136	0.891±0.166	1,513	0.747±0.238	
Insurance					<0.001
National health insurance	10,528	0.929±0.12	2,268	0.788±0.206	
Medical aid	406	0.808±0.207	183	0.647±0.282	
None	8	0.976±0.06	2	0.563±0.256	
Private insurance					<0.001
Yes	6,385	0.947±0.091	896	0.83±0.16	
No	4,557	0.889±0.17	1,557	0.743±0.241	
Living status					<0.001
Alone	1,138	0.872±0.187	504	0.712±0.264	
With others	9,804	0.93±0.119	1,949	0.792±0.202	
Smoking status					<0.001
Never	6,205	0.917±0.132	1,894	0.776±0.215	
Past	2,607	0.936±0.121	215	0.761±0.227	
Current	2,130	0.932±0.117	344	0.797±0.212	
Residence					<0.001
Urban	8,105	0.931±0.118	1,551	0.787±0.206	
Rural	2,873	0.907±0.148	902	0.759±0.232	
Hypertension					<0.001
No	5,461	0.934±0.111	885	0.792±0.217	
Yes	5,481	0.915±0.141	1,568	0.769±0.214	
Diabetes mellitus					<0.001
No	8,380	0.933±0.114	1,721	0.788±0.215	
Yes	2,562	0.898±0.156	732	0.753±0.214	
Dyslipidemia					<0.001
No	5,287	0.933±0.114	1,132	0.793±0.203	
Yes	5,655	0.917±0.136	1,321	0.764±0.224	
Stroke					<0.001
No	10,551	0.928±0.122	2,345	0.782±0.21	
Yes	391	0.83±0.205	108	0.673±0.312	
Myocardial infarction or ischemic heart disease					<0.001
No	10,431	0.927±0.123	2,316	0.779±0.214	
Yes	511	0.875±0.175	137	0.742±0.235	
Asthma					<0.001
No	10,672	0.927±0.123	2,338	0.781±0.212	
Yes	270	0.845±0.208	115	0.703±0.264	

(Continued to the next page)

Table 1. Continued

Characteristic	Weighted EQ-5D index score				P-value
	Participants without OA		Participants with OA		
	N	Mean±SD	N	Mean±SD	
Renal failure					<0.001
No	8,602	0.932±0.118	1,745	0.794±0.202	
Yes	2,340	0.893±0.161	708	0.733±0.243	
Depression					<0.001
No	10,595	0.928±0.122	2,292	0.785±0.209	
Yes	347	0.809±0.197	161	0.666±0.279	

All data are weighted. P-value from chi-square test for categorical variables.
EQ-5D, European quality of life-5 dimensions; OA, osteoarthritis; SD, standard deviation.

W.A. Baum Co., Copiague, NY, USA) was used in the examination. Hypertension was diagnosed if participants were taking hypertension medication, if average systolic blood pressure was ≥140 mm Hg, or if average diastolic blood pressure was ≥90 mm Hg.

Patients with diabetes were defined as those who were diagnosed by a physician during the basic examination survey. Those who were taking oral hypoglycemic agents or insulin, had a fasting blood sugar level of 126 mg/dL or greater, or had a hemoglobin A1c level of 6.5% or higher after more than 8 hours of fasting in the examination survey were also deemed to have diabetes. Patients with dyslipidemia were defined as those who were diagnosed by a physician or were taking lipid-lowering agents, had total cholesterol levels ≥240 mg/dL, had low-density lipoprotein cholesterol levels ≥160 mg/dL after more than 8 hours of fasting, or whose triglyceride levels were >200 mg/dL after more than 12 hours of fasting. Patients with renal failure were defined as those who were diagnosed by a physician during the basic examination survey or who exhibited a glomerular filtration rate <60 mL/min/1.73 m^2 as calculated with the Cockroft–Gault formula using body weights and creatinine levels acquired during the examination survey.

4) Assessment of health-related quality of life

The European quality of life-5 dimensions (EQ-5D) was used for HRQoL assessment. Based on the questionnaire responses to whether any problems exist in the 5 dimensions of health (mobility, self-care, routine activities, pain/discomfort, and anxiety/depression; each scored as "no", "moderate", or "extreme"), the EQ-5D was weighed as previously reported in 2007.[13] The highest EQ-5D index score of 1 indicates a perfect health condition, whereas a lower score is interpreted as a lower quality of life. The use of the EQ-5D as an assessment tool for HRQoL in patients with OA has previously been validated.[14]

3. Data Analysis

The raw KNHNES data were integrated and reflected by the weights suggested in the guideline for raw data analysis to project the survey participants as representative of the entire Korean population. To investigate HRQoL data according to demographic and health factors, we divided the participants according to the presence or absence of OA to obtain the mean EQ-5D index. Subsequently, a chi-square test was performed.

Linear regression analysis was conducted to determine the effect of OA combined with each of the 8 chronic diseases on HRQoL and to assess the interaction between OA and these chronic diseases by obtaining the β coefficient and a 95% confidence interval (CI). Model 1 evaluated for the interaction term between OA and each of the chronic conditions. Model 2 added sex and age; model 3, socio-economic factors; and model 4, the remaining factors described above. STATA ver. 14.0 (Stata Corp., College Station, TX, USA) was used for all the analyses. P<0.05 was considered statistically significant.

RESULTS

Among the 13,395 subjects selected from a total of 16,829 KNHNES participants aged 50 years or older, 2,453 had OA. The EQ-5D index of those with OA (weighted mean±standard deviation [SD], 0.777±0.216) was lower than that of subjects without OA (weighted mean±SD, 0.925±0.126). The mean difference was -0.145 with a 95% CI of -0.138 to -0.151 (P<0.001).

No association was found between smoking or health insurance and the EQ-5D index. However, those who were older in age, female, of low household income or low education level, unemployed, living alone, without private insurance, and living in eup/myeon showed a lower EQ-5D index.

The quality of life was lower in those who had chronic conditions and OA than in those with chronic diseases only. The combination of chronic conditions and OA produced an additive relationship with respect to diabetes and depression, but a subtractive relationship with respect to cardiovascular disease and asthma. The combination of OA and 4 diseases (hypertension, dyslipidemia, stroke, and renal failure) showed a synergistic relationship with a lower-than-expected EQ-5D (Table 1).

The β coefficient for the interaction term was significant only in renal failure and remained so after adjusting for demographic and socio-economic variables (model 4: β coefficient for interaction term, -0.034; 95% CI, -0.055 to -0.012) (Table 2, Figure 1).

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Table 2. β Coefficient for interaction term with osteoarthritis and chronic health condition

Variable	Model 1	Model 2	Model 3	Model 4
Hypertension				
No	0 (Reference)	0 (Reference)	0 (Reference)	0 (Reference)
Yes	-0.004 (-0.026 to 0.017)	-0.002 (-0.023 to 0.018)	-0.004 (-0.024 to 0.016)	-0.004 (-0.025 to 0.016)
Diabetes mellitus				
No	0 (Reference)	0 (Reference)	0 (Reference)	0 (Reference)
Yes	0.000 (-0.022 to 0.021)	0.005 (-0.016 to 0.025)	0.002 (-0.018 to 0.021)	0.001 (-0.019 to 0.021)
Dyslipidemia				
No	0 (Reference)	0 (Reference)	0 (Reference)	0 (Reference)
Yes	-0.013 (-0.034 to 0.007)	-0.010 (-0.030 to 0.009)	-0.007 (-0.025 to 0.012)	-0.007 (-0.026 to 0.011)
Stroke				
No	0 (Reference)	0 (Reference)	0 (Reference)	0 (Reference)
Yes	-0.011 (-0.080 to 0.059)	-0.011 (-0.079 to 0.058)	-0.016 (-0.084 to 0.052)	-0.015 (-0.083 to 0.053)
Myocardial infarction or ischemic heart disease				
No	0 (Reference)	0 (Reference)	0 (Reference)	0 (Reference)
Yes	0.015 (-0.024 to 0.055)	0.016 (-0.024 to 0.056)	0.009 (-0.029 to 0.048)	0.009 (-0.031 to 0.048)
Asthma				
No	0 (Reference)	0 (Reference)	0 (Reference)	0 (Reference)
Yes	0.004 (-0.050 to 0.057)	-0.016 (-0.066 to 0.034)	-0.030 (-0.076 to 0.017)	-0.029 (-0.076 to 0.017)
Renal failure				
No	0 (Reference)	0 (Reference)	0 (Reference)	0 (Reference)
Yes	-0.022 (-0.044 to 0.001)	-0.026 (-0.048 to -0.004)	-0.034 (-0.055 to -0.012)	-0.034 (-0.055 to -0.012)
Depression				
No	0 (Reference)	0 (Reference)	0 (Reference)	0 (Reference)
Yes	0.001 (-0.050 to 0.051)	-0.010 (-0.060 to 0.040)	-0.015 (-0.062 to 0.031)	-0.014 (-0.061 to 0.033)

Values are presented as mean (95% confidence interval). Model 1: simple; model 2: adjusted for age and sex; model 3: adjusted for age, sex, occupation, insurance, and private insurance; model 4: adjusted for age, sex, occupation, insurance, private insurance, living status, smoking status, and residence.

DISCUSSION

To the best of our knowledge, this study is the first to investigate the effect of OA, either independently or combined with individual chronic conditions, on the quality of life in elderly Korean individuals. We posit that patients with OA experienced decreased HRQoL owing to the fact that OA causes pain, physical disabilities, decreased mobility and function, and mental health problems.[3-6] These, in turn, were revealed in the change of the EQ-5D index. The change in HRQoL is also likely attributable to the comorbid chronic conditions; the decreased quality of life observed with chronic comorbidities mostly showed an additive or synergistic relationship, which is consistent with previous studies that assessed the effects of comorbidities in chronic conditions other than OA.[10,15-17]

The common pathophysiology between renal failure and OA remains unknown. Cohen et al.[18] revealed that 69% of patients with chronic renal diseases experience pain and 55.2% of them have a sleeping disorder. Experiencing pain decreases the quality of life because of depression, disease burden, and decreased fulfillment with life. Meanwhile, sleeping disorder decreases the quality of life because of depression, disease burden, social support, and pain frequency. Decreased renal function can limit the pain control of patients with OA, and end-stage renal disease is related to decreased HRQoL and increased length of hospital stay.[19] Renal failure combined with OA are likely to produce their synergistic effect because of the propensity of each to produce pain, physical disabilities, and decreased mobility, as well as mental health problems.

The fact that OA combined with cardiovascular disease or asthma produce a subtractive effect is likely because the relative effects of these non-OA comorbidities on the quality of life are severe. Hence, having OA does little to suppress the quality of life further. Furthermore, patients with a very low quality of life were likely to have already died or were not included in the study because of their inability to participate in the questionnaire or examination survey.

The strength of this study lies in the fact that it used data from the KNHNES, which represents the entire Korean population. It is a large-scale study that includes data from 2009, when radiography for OA was first introduced in the KNHNES, to 2013, the most recent year in which data were available. However, the locations of affected joints vary; diagnosis of OA is subject to inconsistent definitions and criteria, and radiological examinations are required for clinical confirmation.[20] Controversy also exists over the identification of OA patients,[21] because many do not show any symptoms or disabilities even though they are radiologically diagnosed with OA.[22] Therefore, we supplemented the criteria for classifying patients with OA to include those newly deemed to have OA based on their symptoms and radiological findings in addition to relying on responses to the self-reported questionnaire for those who had previously been diagnosed with OA.

The limitations of this study are as follows. First, the study did not include information on the severity of OA and comorbid chronic dis-

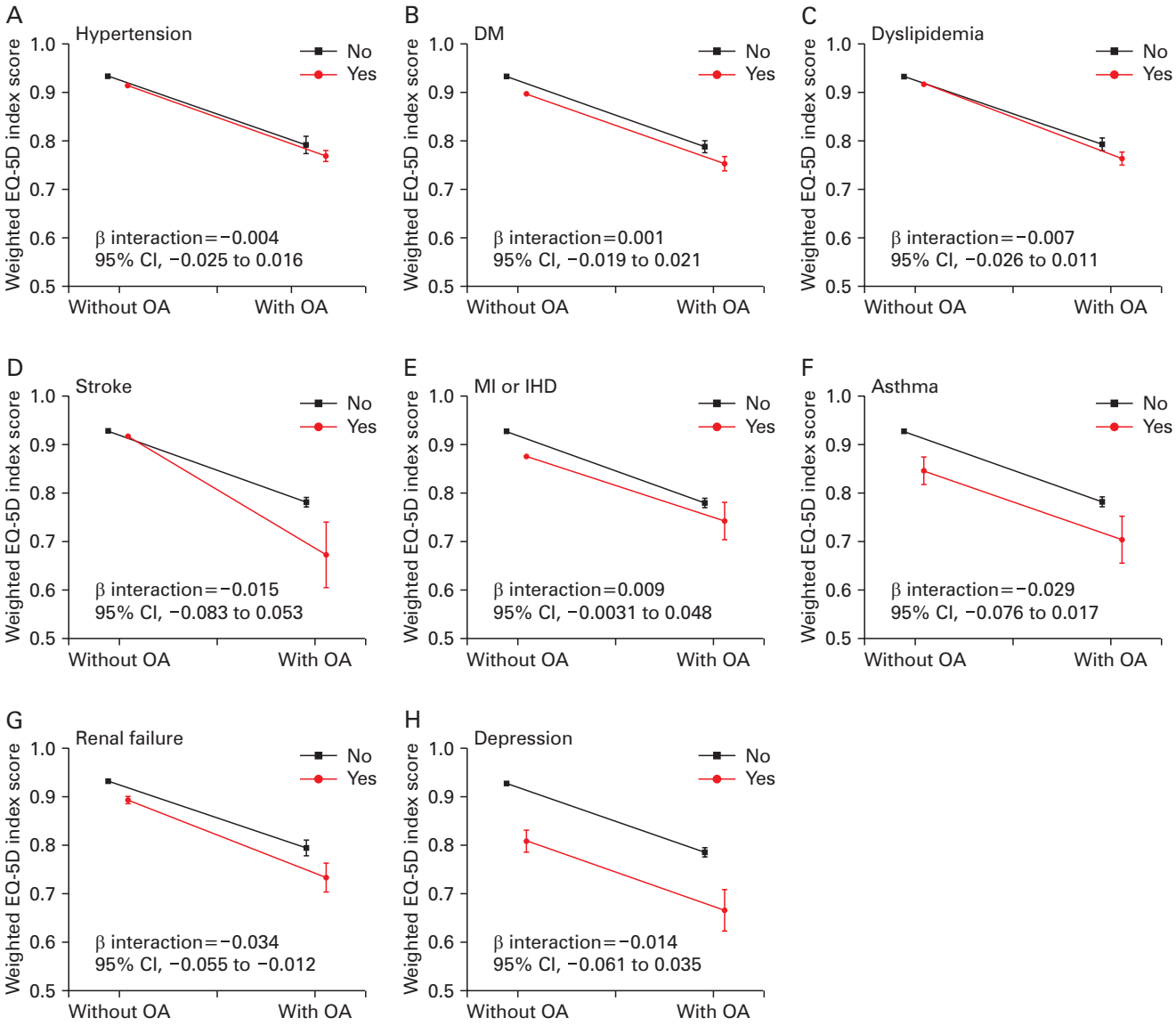

Figure 1. (A–H) Model based predictive means (95% CIs) of osteoarthritis-stratified EQ-5D index scores for chronic health conditions. EQ-5D, European quality of life-5 dimensions; CI, confidence interval; DM, diabetes mellitus; MI, myocardial infarction; IHD, ischemic heart disease; OA, osteoarthritis.

eases, or whether ailments were being treated at the time of the survey. Second, the definition of patients with OA differed in previous studies and epidemiologic surveys owing to the absence of common criteria for the diagnosis of OA (which is a fundamental problem), making it difficult to compare results. Different definitions and diagnosis criteria were employed due to the difficulties mentioned above; these may contribute to the heterogeneity of the results, including OA estimates.[23-26] Third, the data may be subject to recollection errors because identification of chronic conditions was based on questionnaire responses. Those who use health services less frequently were not likely to be diagnosed properly. Therefore, this study strictly defined each of the chronic diseases using both the results of the questionnaire combined with the results of the examination survey. Lastly, investigation on the causality between chronic conditions and decreased HRQoL is not possible owing to the limitations of a cross-sectional study. A cohort study is required to investigate causality regarding the health of the elderly population in the future. Moreover, determining whether a combination of 3 or more diseases shows outcomes consistent with what we observed in this study is necessary.

In conclusion, we showed that OA significantly affects HRQoL and exerts a more negative effect when accompanied by other chronic conditions. In particular, the decline in HRQoL is much greater when combined with hypertension, dyslipidemia, stroke, and renal failure. The results of the present study emphasize the importance of managing OA, as patients with this disease often do not seek medical intervention. The symptoms of this disease are assumed to be due to normal aging, causing the severity and consequences of the disease to be underestimated.

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CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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