Prevalence of and risk factors for shoulder osteoarthritis in Japanese middle-aged and elderly populations

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Background: The purpose of this study was to determine the prevalence of shoulder osteoarthritis (OA) in populations older than 40 years and to examine risk factors and the relationship with shoulder function.

Methods: The respondents in this study consisted of 541 patients who underwent general medical examinations in April 2012 as residents of a single village. The mean age was 65.2 ± 11.0 years (range, 40-89 years), and 341 (63.0%) of the respondents were women. Anteroposterior radiographs of the bilateral shoulder joints were obtained, and the subjects were classified into 3 groups (non-OA, mild OA, and moderate-severe OA) according to the Samilson-Prieto method. With respect to risk factors for shoulder OA, a logistic regression analysis was performed.

Results: Shoulder OA was detected in 17.4% (94 of 541) of the patients. The incidence of OA in both shoulders was 3.1% (17 of 541), and the prevalence of shoulder OA among the respondents 65 years of age or older (20.3%) was significantly higher than that observed among the respondents younger than 65 years (11.1%). The risk of shoulder OA increased according to age, with an odds ratio of 5.59 in the respondents 60 to 69 years of age (P = .027), 11.59 in the respondents 70 to 79 years of age (P = .004), and 10.77 in the respondents 80 years of age and older (P = .004).

Conclusions: The prevalence of shoulder OA was 17.4%, and the risk factor for shoulder OA was age.

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Keywords: Shoulder; osteoarthritis; risk factor; medical complications; prevalence; logistic regression analysis

Osteoarthritis (OA) is an important clinical condition that is an obstacle to the performance of activities of daily living in elderly patients. It has been reported that systemic factors, such as age, gender, ethnicity, and genes, as well as local factors, such as the load on weight-bearing joints, history of trauma, obesity, and changes in the joint structure due to fractures, are contributors to OA.1

Understanding the clinical conditions of OA and pursuing proper treatment methods are important subjects in Japan from the perspective of medical economics and the fact that it is a country well on its way to becoming an aging society. A large number of studies of weight-bearing joints, such as...
the knee and hip joints, have been conducted, with a wide range of examinations regarding the prevalence of OA and its association with medical conditions or risk factors.\textsuperscript{3,4,6} However, most epidemiologic studies have focused on the development of shoulder OA after shoulder dislocation\textsuperscript{7} or Bankart reconstruction.\textsuperscript{13} Hovelius\textsuperscript{5} found that 56% of shoulders in patients 37 to 65 years of age exhibit arthropathy (mild-severe) 25 years after dislocation. Furthermore, the prevalence of OA is known to differ among ethnic groups, and although it has been reported that Asians have a lower prevalence of primary shoulder OA than Westerners do,\textsuperscript{2,7,10,16} no reports exist regarding epidemiologic studies of shoulder OA among the general population in Japan.

Our hypothesis is that the prevalence of shoulder OA among middle-aged and elderly populations in Japan is not low. Therefore, the purpose of this study was (1) to investigate the prevalence of shoulder OA among populations 40 years of age and older in Japan, (2) to clarify the clinical characteristics of shoulder OA, and (3) to analyze risk factors for shoulder OA.

**Materials and methods**

This is a cross-sectional, prevalence study of the prevalence of and risk factors for shoulder OA in Japanese middle-aged and elderly populations.

**Subjects**

An epidemiologic study of shoulder OA among middle-aged and elderly populations was designed as a cross-sectional study. In planning the study, a statistical power analysis was used. The target sample size of this study was calculated to be 252 persons, based on the effect size as medium, a significance level of 5%, and a statistical power of 0.95, according to the $\chi^2$ test. Patients 40 years of age or older were the targets of a survey, with more than 300 persons selected as subjects, taking into consideration incomplete samples. On receiving approval from the Institutional Review Board of our institute, the purpose of this study was explained to patients receiving medical examinations among the general population of Katashina Village in Gunma Prefecture in April 2012, and signed informed consent was obtained from 541 subjects to participate in the medical examinations.

There were 25 respondents (4.6%) with a history of shoulder trauma on the dominant side, 23 respondents (4.3%) with a history of shoulder trauma on the nondominant side, and 9 respondents (1.7%) with a history of shoulder trauma on bilateral sides. Katashina Village is a rural area with agriculture, forestry, and tourism as major industries. The population 40 years of age or older totals 3300 individuals (1540 men and 1760 women) according to the 2010 national census, such that the subjects of this study accounted for approximately 33.7% of the total population of the village.

**Survey of background factors including medical comorbidities**

The age, gender, and body mass index of the respondents along with the incidence of diabetes, hypertension, and hyperlipidemia as medical comorbidities were investigated on the basis of the results of medical interviews, biochemical blood tests, and blood pressure measurements obtained during the medical examinations. The diagnostic criteria for diabetes were a hemoglobin A1c level of $\geq 6.5\%$ or a fasting blood glucose level of $\geq 140$ mg/dL, or a blood glucose level of $\geq 200$ mg/dL. The diagnostic criteria for hypertension were a systolic blood pressure of $\geq 140$ mm Hg or a diastolic blood pressure of $\geq 90$ mm Hg and a past history of hypertension based on the medical interview. The diagnostic criteria for hyperlipidemia were a low-density lipoprotein cholesterol level of $\geq 140$ mg/dL and a high-density lipoprotein cholesterol level of $<40$ mg/dL or a triglyceride level of $\geq 150$ mg/dL and a past history of hyperlipidemia based on the medical interview.

There were no differences in age between the men and women. The values for height, weight, and body mass index and the prevalence of diabetes and hypertension were higher in men than in women (Table I).

We stratified the respondents according to age (40-49 years: 40s; 50-59 years: 50s; 60-69 years: 60s; 70-79 years: 70s; and 80 years and older: 80s). The prevalence of hypertension was 12.7% (7 of 55) in the patients in their 40s, 17.6% (20 of 114) in the patients in their 50s, 25.3% (38 of 150) in the patients in their 60s, 33.3% (67 of 171) in the patients in their 70s, and 39.2% (20 of 51) in the patients in their 80s.

**Investigation of shoulder pain**

The presence of shoulder pain within the last 2 weeks was investigated by medical interviews conducted during the medical examinations. The respondents were asked about the presence of shoulder pain under separate conditions (during rest, during motion, and at night) to assess each type of pain with a 100-mm visual analog scale. With respect to the subsequent data analysis, more than 20 mm was defined as the presence of pain, with measured scale values used for the assessment of pain.

**Survey of shoulder function**

The shoulder range of motion and muscle strength were measured to assess shoulder function. The range of motion was measured with a goniometer for the active and passive range of motion during flexion, abduction, and external rotation. Furthermore, with regard to muscle strength, abduction at 90° of abduction on the scapular plane and the external rotation strength were measured with a spring balance (Shinwa Rules Co, Ltd, Niigata, Japan); the measurement units are kilograms. The measurements were obtained 3 times each for both shoulders in the sitting position, with the mean value used for the data analysis.

**Diagnosis of shoulder OA on radiography**

An anteroposterior radiograph of the bilateral shoulder joints was obtained to diagnose shoulder OA. The radiographic images were saved in the format of Digital Imaging and Communications in Medicine (DICOM) and stored by attaching a common ID with the medical examination list. Later, two orthopedists (T.K., 20 years of experience in shoulder surgery; K.T., 37 years of experience in shoulder surgery) interpreted the radiographs on
separate occasions without revealing the other assessment items using the DICOM viewer software Natural View Portable (Hitachi Medical Corporation, Tokyo, Japan). The Samilson-Prieto classification was used for the diagnosis of OA. The S-P classification divides glenohumeral OA into 4 grades: grade 0, normal; grade 1, mild (osteophytes < 3 mm on the humeral head); grade 2, moderate (osteophytes between 3 and 7 mm on the humeral head or glenoid rim); and grade 3, severe (osteophytes > 7 mm, with or without articular incongruity). We assigned cases of cuff tear arthropathy and humeral head deformities caused by fractures into the secondary OA group. With respect to the statistical tests, the data analysis was conducted by combining grades 2 and 3 as moderate-severe OA because the number of respondents with severe OA was too small (n = 8).

The intertester reliability between authors T.K. and K.T. and the intraclass reliability when K.T. interpreted the radiographs again 2 weeks later were calculated. The interclass coefficient against intraclass reliability was 0.83, and that against intertester reliability was 0.80, for the diagnosis of shoulder OA in 1082 shoulders among 541 patients on radiographs. In this study, we adopted the data interpreted by author T.K.

### Statistical analyses

First, the prevalence of shoulder OA was obtained on the basis of the acquired data to clarify the characteristics according to age and OA classification.

Second, a comparative examination was conducted between the shoulder OA group and the non-OA group to clarify the characteristics of the patients with shoulder OA by Student t test and Welch test for continuous variables and Fisher exact test and χ² test for categorical data. For comparisons between the groups of shoulder OA, an analysis of variance was used for continuous variables, followed by the Games-Howell test. The χ² test was used for categorical data.

With respect to the risk factors for shoulder OA, a univariate logistic regression analysis was performed, followed by a multivariate logistic regression analysis using significant examination items obtained from the univariate analysis as explanatory variables.

A risk ratio of less than 5% was defined as a significant difference with use of the SPSS version 21 software program (SPSS, Chicago, IL, USA).

### Results

#### Prevalence of shoulder OA

Shoulder OA was detected in 17.4% (94 of 541) of the respondents, with 3.1% (17 of 541) exhibiting OA on both sides. Furthermore, 8 shoulders in 8 subjects (1.5%) exhibited cuff tear arthropathy, and 1 shoulder in 1 subject (0.2%) exhibited a deformity as the cause of the fracture (Table I).

The prevalence of OA was 1.8% in the patients in their 40s, 9.6% in the patients in their 50s, 14.7% in the patients in their 60s, 26.9% in the patients in their 70s, and 27.5% in the patients in their 80s. Regarding the degree of progression of OA, mild OA was observed in 11.1% of the patients and moderate-severe OA was observed in 6.3% of the patients, thus revealing an increase in the frequency of advanced OA with aging (Table II).

The prevalence of OA was 1.8% in the patients in their 40s, 9.6% in the patients in their 50s, 14.7% in the patients in their 60s, 26.9% in the patients in their 70s, and 27.5% in the patients in their 80s. Regarding the degree of progression of OA, mild OA was observed in 11.1% of the patients and moderate-severe OA was observed in 6.3% of the patients, thus revealing an increase in the frequency of advanced OA with aging (Table III).

The prevalence of OA in the middle-aged population (younger than 65 years) was 11.1% (19 of 171 persons), whereas that in the elderly population (65 years of age and older) was 20.3% (75 of 370 persons). According to the χ² test, the prevalence of shoulder OA was significantly higher in the elderly population (P = .010).
Clinical characteristics of shoulder OA

Regarding the clinical characteristics of the respondents with shoulder OA, there were no significant differences between the groups in gender, height, weight, body mass index, or hand dominance. The incidence of hypertension increased in association with the progression of OA (Table IV). The prevalence of hypertension was 12.7% (7 of 55) in the patients in their 40s, 17.6% (20 of 114) in the patients in their 50s, 25.3% (38 of 150) in the patients in their 60s, 33.3% (67 of 171) in the patients in their 70s, and 39.2% (20 of 51) in the patients in their 80s.

There were negative correlations between pain at rest and active/passive flexion ($r = -0.124/-0.116$), pain at rest and active/passive abduction ($r = -0.113/-0.106$), and pain at rest and abduction/external rotation strength ($r = -0.170/-0.129$). There were negative correlations between pain during motion and active/passive flexion ($r = -0.214/-0.207$), pain during motion and active/passive abduction ($r = -0.160/-0.155$), and pain during motion and abduction strength ($r = -0.168$). There were negative correlations between pain at night and active/passive flexion ($r = -0.210/-0.198$), pain at night and active/passive abduction ($r = -0.197/-0.215$), pain at rest and abduction/external rotation strength ($r = -0.105/-0.120$), and pain at night and abduction/external rotation strength ($r = -0.164/-0.101$). However, the presence of shoulder pain was not correlated with the degree of OA.

Active flexion, active external rotation, and passive external rotation were significantly lower in the moderate-severe OA group than in the non-OA group, with a mean active flexion of 153° ± 9° in the moderate-severe OA group and 158° ± 10° in the non-OA group ($P = 0.045$), a mean active external rotation of 33° ± 10° in the moderate-severe OA group and 42° ± 15° in the non-OA group ($P = 0.002$), and a passive external rotation of 36° ± 14° in the moderate-severe OA group and 43° ± 15° in the non-OA group ($P = 0.014$). With regard to the muscle strength of abduction and external rotation, no relationships were observed with the degree of OA.

Risk factors for shoulder OA

We performed a univariate logistic regression analysis of the 2 groups (non-OA group and OA group) with respect to
age, gender (male), and hand dominance and the presence or absence of diabetes, hypertension, and hyperlipidemia.

We found age and the presence of hypertension to be significant risk factors as a result of a univariate logistic regression analysis. The odds ratios for the 60s, 70s, and older than 80s against the 40s were 9.78, 19.29, and 20.43, respectively. No significant differences were found in the 50s. Hypertension was also a significant risk factor, with an odds ratio of 1.69 (Table V).

As a result of the multivariate logistic regression analysis, age was found to be a significant risk factor, with odds ratios for the 60s, 70s, and older than 80s against the 40s of 5.59, 11.59, and 10.77, respectively. Furthermore, no significant differences were found in the 50s (Table VI).

Discussion

In this study, shoulder OA was detected in 17.4% of the population 40 years of age or older.

van Schaardenburg et al16 reported the prevalence of shoulder OA in the general population, with an incidence of the condition among subjects older than 85 years of 4%. However, in that report, the diagnosis of shoulder OA was based on only physical findings; therefore, it is difficult to compare their findings with our results.

In a survey conducted in Korea by Oh et al11 that targeted general groups 65 years of age and older, shoulder radiographs were obtained in a similar manner as in this study, and shoulder OA was diagnosed by use of the S-P classification. Consequently, the prevalence of the disease was reported to be 16.1%. The prevalence of shoulder OA was 20.3% in those 65 years of age or older in our study. This prevalence survey was focused on an area with agriculture, forestry, and tourism as major industries. The survey area in the report by Oh et al11 was a suburban area in Korea. Therefore, we believe that the difference in prevalence was due to the differences in the survey areas.

There are several hospital-based studies of shoulder OA. Nakagawa et al10 examined the prevalence of shoulder OA among patients visiting hospitals who received shoulder radiographs and reported an incidence of 0.4%. The qualifying age in that study ranged from 1 to 88 years. Limiting the qualifying age to 70 years or older increased the prevalence of shoulder OA to 13.3%. In our results, the prevalence of shoulder OA in the patients older than 70 years was 27.0% (60 shoulders in 222 respondents). We found age and the presence of diabetes, hypertension, and hyperlipidemia to be significant risk factors as a result of a univariate logistic regression analysis. The odds ratios for the 60s, 70s, and older than 80s against the 40s of 8.22, 11.59, and 10.77, respectively. Furthermore, no significant differences were found in the 50s (Table VI).

Kircher et al7 commented that the physical and radiologic findings of shoulder OA do not necessarily coincide. Therefore, we assume that their report, which defined shoulder OA on the basis of clinical findings only, does not convey the actual prevalence of the condition.

In this study, the prevalence of shoulder OA in respondents younger than 65 years was 11.1% (19 of 171 persons), whereas in respondents 65 years of age or older was 20.3% (75 of 370 persons). According to the \( \chi^2 \) test, the prevalence of shoulder OA was significantly higher in the elderly population \( (P = .010) \). Nakagawa et al10 reported that the disease is significantly more prevalent in patients 60 years of age or older than in patients younger than 60 years. In Petersson’s12 anatomic study, no degenerative changes were found before 60 years of age; however, after 60 years of age, cartilage degeneration appeared and increased in frequency with age.

In the present study, a total of 66 of 1081 shoulders were associated with a history of a traumatic event based on the medical interviews, and secondary OA evaluated on radiography was observed in only 9 shoulders (13.6%). Among the remaining 1015 shoulders, 74 (7.3%) exhibited radiographic OA. We performed the \( \chi^2 \) test to determine whether a history of trauma is a risk factor for shoulder OA and found that the incidence of a history of trauma was not significantly different between the groups \( (P = .09) \).

Hovelius5 found that 56% of shoulders in patients 37 to 65 years of age exhibited arthropathy 25 years after dislocation. In Western countries, it has been reported that the most common cause of shoulder arthropathy is shoulder dislocation. Although the presence of a history of

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**Table V** Risk factors for shoulder osteoarthritis (univariate logistic regression analysis)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds ratio</th>
<th>95% Confidence interval</th>
<th>( P )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40-49 years</td>
<td>Reference</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50-59 years</td>
<td>5.77</td>
<td>0.73-45.86</td>
<td>.098</td>
</tr>
<tr>
<td>60-69 years</td>
<td>9.78</td>
<td>1.29-74.26</td>
<td>.027*</td>
</tr>
<tr>
<td>70-79 years</td>
<td>19.29</td>
<td>2.59-143.52</td>
<td>.018*</td>
</tr>
<tr>
<td>≥ 80 years</td>
<td>20.43</td>
<td>2.58-162.16</td>
<td>.027*</td>
</tr>
<tr>
<td>Gender (male)</td>
<td>0.68</td>
<td>0.94-2.32</td>
<td>.057</td>
</tr>
<tr>
<td>Diabetes</td>
<td>1.11</td>
<td>0.44-2.79</td>
<td>.823</td>
</tr>
<tr>
<td>Hypertension</td>
<td>1.69</td>
<td>1.03-2.77</td>
<td>.038*</td>
</tr>
<tr>
<td>Hyperlipidemia</td>
<td>0.95</td>
<td>0.59-1.55</td>
<td>.901</td>
</tr>
</tbody>
</table>

* Statistical significance.
trauma was not found to be a significant risk factor in our results, physicians should take into account a history of trauma when performing medical examinations for shoulder OA.

There were no significant differences between the groups in terms of gender, height, weight, body mass index, and hand dominance. The incidence of hypertension increased in association with the progression of OA. The prevalence of hypertension was 12.7% (7 of 55) in the patients in their 40s, 17.6% (20 of 114) in the patients in their 50s, 25.3% (38 of 150) in the patients in their 60s, 33.3% (67 of 171) in the patients in their 70s, and 39.2% (20 of 51) in the patients in their 80s. Sowers et al suggested that a hormone deficiency in elderly women may be a reason for the increased incidence of knee OA. In contrast, Oh et al stated that the presence of a hormone deficiency alone cannot explain why this gender risk factor does not carry over to the shoulder joint. Therefore, we believe that genetic or environmental factors that differ according to gender may play a role in the progression of shoulder OA.

There were negative correlations between pain and the shoulder range of motion and between pain and shoulder muscle strength, whereas the presence of shoulder pain was not correlated with the degree of OA. Yamamoto et al reported that in their study, the prevalence of rotator cuff tears in each generation was 0% among subjects in their 20s, 2.5% among subjects in their 30s, 6.7% among subjects in their 40s, 12.8% among subjects in their 50s, 25.6% among subjects in their 60s, 45.8% among subjects in their 70s, and 50.0% among subjects in their 80s, with the prevalence of the condition increasing with age. Therefore, we speculate that the respondents with shoulder pain may be affected by rotator cuff tears or other shoulder disorders.

Active flexion, active external rotation, and passive external rotation were significantly lower in the moderate-severe OA group than in the non-OA group. Kircher et al reported that the size of the spur is negatively correlated (active and passive) with flexion, abduction, external rotation, and internal rotation. They also reported that the presence of osteophytes decreases the joint volume and tightens the capsule, thereby mechanically restricting joint motion.

In our study, the multivariate logistic regression analysis confirmed that the incidence of shoulder OA increases with age, with an odds ratio of 5.59 in patients 60 to 69 years of age ($P = .004$), 10.77 in patients 70 to 79 years of age ($P = .004$), and 20.3% in patients older than 80 years ($P = .004$) compared with those 40 to 49 years of age. Several reports have suggested a mechanism for age-related OA changes. Cell senescence is responsible for the age-related deterioration of the chondrocyte function, which decreases the ability of cells to maintain and to restore articular cartilage, resulting in OA.

There are some limitations in this study. First, we used the S-P classification as the radiographic assessment method for evaluating shoulder OA. This classification was originally developed for the radiographic assessment of the shoulder joint after surgery for instability. In addition, we obtained only one radiographic view. As Oh et al stated, the development of a generally accepted single classification system for assessment of shoulder OA is needed.

The second point is that the radiographs used in this study showed only the anteroposterior view. Although it is desirable to have two directions with an additional axis view in assessing shoulder OA, the limited time available for the medical examinations left us with no choice but to assess the shoulder joint with the anteroposterior view alone. However, the S-P classification can be based on the anteroposterior radiographic view of the shoulder joint, and it is believed that it is appropriate to use the S-P classification from this standpoint. The third point is that this study is a cross-sectional study. The natural course of cartilage aging in the shoulder joint remains unclear and requires further investigation. The last point is that the prevalence of hypertension was evaluated by medical interviews in this study. Therefore, we are unable to discuss how many patients received medications for hypertension, and the prevalence of hypertension may be inaccurate in a precise sense.

Conclusions

An epidemiologic survey of shoulder OA with radiography was conducted among middle-aged and elderly subjects in Japan. In this study, the prevalence of OA was 17.4% in the respondents older than 40 years, and the subjects in the OA group were older than those in the non-OA group. The prevalence of shoulder OA in the respondents younger than 65 years was 11.1%, whereas that in the respondents 65 years of age or older was 20.3%. The prevalence of shoulder OA was significantly higher in the respondents 65 years of age or older. As a result of the multivariate logistic regression analysis, age was found to be a risk factor for shoulder OA.

Acknowledgments

We would like to express our sincere thanks and appreciation to the people who underwent medical examinations from for the general population in Katashina Village, the public health nurses of Katashina Village of Gunma Prefecture, the radiation technologists of San-aiikai Hospital, the orthopaedic surgeons in the Department of Orthopaedic Surgery of Gunma University Graduate School of Medicine, and the medical students at Gunma University Faculty of Medicine for their great support and cooperation in implementing medical examinations for shoulder osteoarthritis at this time.
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The authors, their immediate families, and any research foundation with which they are affiliated did not receive any financial payments or other benefits from any commercial entity related to the subject of this article.

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