Annals of Occupational and
Environmental Medicine

AOEM

Original Article

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Radiographic hand osteoarthritis in women farmers: characteristics and risk factors

Bohyun Sim (iD), **Jaehoo Lee** (iD), **Chul Gab Lee** (iD), **and Hansoo Song** (iD) *

Department of Occupational and Environmental Medicine, Chosun University Hospital, Gwangju, Korea

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*Correspondence:

Hansoo Song

Department of Occupational and
Environmental Medicine, Chosun University
Hospital, 365 Pilmun-daero, Dong-gu,
Gwangju 61453, Korea.
Email: oemsong@chosun.ac.kr

ORCID iDs
Bohyun Sim (iD)
https://orcid.org/0000-0001-6996-018X
Jaehoo Lee (iD)
https://orcid.org/0000-0001-7365-8952
Chul Gab Lee (iD)
https://orcid.org/0000-0001-7017-2623
Hansoo Song (iD)
https://orcid.org/0000-0001-6000-1572

Abbreviations
APR: adjusted PR; BMI: body mass index; CI:
confidence interval; CMC1: carpometacarpal
joint in the thumb; DIP: distal interphalangeal
joint; IP1: interphalangeal joint in the thumb;
JSN: joint space narrowing; Lt.: left; MCP:

ABSTRACT

Background: Repetitive hand use increases the risk of hand osteoarthritis (OA). This study
aimed to investigate characteristics of and risk factors for hand OA in Korean women farmers.
Methods: This cross-sectional study included women farmers resident in Jeollanam-do,
Korea. The participants were interviewed, and radiographs were taken of both hands.
Radiological hand OA was defined based on the Osteoarthritis Research Society International
imaging criteria of joint space narrowing or the presence of osteophytes. The participants
were divided into age groups of < 60 and ≥ 60 years. Obesity was defined as body mass index
of > 25 kg/m². Annual working time was divided into < 2,000, 2,000–2,999, and ≥ 3,000
hours. Agricultural working type was divided into rice farming and field farming. Robust
Poisson regression was used to identify factors associated with radiographic hand OA, with
adjustment for age, obesity, annual working time, and agricultural classification.
Results: A total of 310 participants with a mean age of 58.1 ± 7.6 years, were enrolled. The
prevalence of radiologically confirmed OA was 49.0%, with an OA prevalence of 39.4%
the interphalangeal joint in the thumb (IP1). The prevalence of OA was higher in the distal
interphalangeal joint than in the proximal interphalangeal, metacarpophalangeal, and
carpometacarpal joints. The prevalence of OA varied by age, annual working time, and
agriculture type.
Conclusions: Korean women farmers have a high prevalence of OA, particularly in the IP1
joints. OA is associated with age, working hours, and agriculture type.

Keywords: Hand osteoarthritis; Women farmers; Field farmers; Distal interphalangeal joint;
Korea

BACKGROUND

Osteoarthritis (OA) of the hand is the most common joint disease in older adults worldwide.[1]
A recent study reported that 67% of women aged > 55 years had hand OA in at least one joint.[2]
Hand OA causes pain and decreases the quality of life by reducing joint function and lowering
grip strength.[3-5] As the population ages, the socioeconomic burden of hand OA continues
to increase.[6] Age,[4] gender,[7] and obesity[8,9] are known risk factors for hand OA. In addition,
occupations that involve repeated use of the hands and heavy physical work are known risk
factors.[10,11] Agriculture is a typical occupation that involves heavy lifting and repeated hand

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metacarpophalangeal joint; OA: osteoarthritis; PIP: proximal interphalangeal joint; PR: prevalence ratio; Rt.: right; SD: standard deviation.

movements. In Korea, agriculture is trending away from rice to field farming including vegetables, fruits, and flowers. Field farming has a lower rate of mechanization than rice farming. Women are mainly engaged in field work while men operate machinery.[12] Field farming requires repetitive movements such as picking, gripping, and grasping. In addition, an awkward posture or excessive force depends on the shape, position, and weight of the crop. Therefore, we expected pinch and grip forces to create more strain on the thumbs and second finger joints.

General population studies have estimated the prevalence of hand OA in the range of 22%–76%.[1316] This prevalence is estimated to be higher in women than in men[17,18] and is expected to increase with age.[4,17,19] At the joint level, the distal interphalangeal (DIP) joints, IP1, and carpometacarpal joint in the thumb (CMC1) tend to have higher rates of OA than the proximal interphalangeal (PIP) joints.[13,14,20,21] However, the relationship between hand OA and occupational factors remains unclear.

There have been several studies on musculoskeletal disorders involving farmers[22] in Korea, including investigations into risk factors for knee[23,24] and back[25-27] diseases. However, there are only a few studies on hand OA in farmers, it has not received attention as an occupational disease, and there are no studies on OA prevalence in each finger joint of women farmers. Therefore, this study aimed to investigate the prevalence of hand OA by finger joints identification and to identify risk factors.

METHODS

This study included 310 women farmers resident in Jeollanam-do who visited the Chosun University Hospital Jeonnam Center for Farmers' Health and Safety, which is funded by the Ministry of Agriculture, Food, and Rural Affairs. The participants were recruited from June 2019 to September 2020.

An occupational health screening program for women farmers was conducted as preliminary project by the Ministry of Agriculture, Food and Rural Affairs. Target diseases for the program were musculoskeletal disease, pesticide poisoning, lung disease, and osteoporosis. This study evaluated hand OA among the musculoskeletal diseases. Participants included women farmers who were registered at the National Farm Business Registration; and participants were enrolled through the Women Farmers' Association. We tried to exclude participants with hand OA due to other causes such as rheumatoid arthritis. Therefore, the serologic test (rheumatoid factor, anti-cyclic citrullinated peptide antibody, erythrocyte sedimentation rate, C-reactive protein) and physical examination was performed to confirm whether criteria for rheumatoid arthritis were satisfied (updated American College of Rheumatology/European League Against Rheumatism Classification).[28] A total score of ≥ 6 is needed to confirm rheumatoid arthritis. All study participants scored < 6 points, so none were excluded due to rheumatoid arthritis.

Radiographic definitions of OA
Standard posteroanterior radiographs of both hands were acquired. Two pre-trained occupational physicians read the radiographs. We evaluated 4 DI, 4 PIP, IP1, 5 metacarpophalangeal (MCP), and CMC1 joints of each hand for joint space narrowing (JSN) and osteophyte presence according to the OA Research Society International atlas.[29] Joint level

OA was defined as JSN of grade ≥ 2, osteophyte of grade ≥ 2, or JSN of grade 1 and osteophyte of grade 1. These cut-offs approximate Kellgren and Lawrence grades ≥ 2.[30] If joint level OA was diagnosed in any joint, it was diagnosed as hand OA in the present study.[4,31] Two occupational physicians read all images and one reader read them twice. Any discrepancies were resolved by consensus and re-examination of the contentious images. The intra-observer and inter-observer kappa values for hand OA were 0.79 and 0.66, respectively. The intra-observer and inter-observer kappa values for the IP1 OA were 0.92 and 0.66, respectively.

Statistical analysis

We investigated the participants' demographic characteristics, including age, body mass index (BMI), annual working time in the past year, and agricultural classification. Age was classified into groups of < 60 and ≥ 60 years. BMI values were categorized as "obesity" (≥ 25 kg/m^2) and "normal" (< 24.9 kg/m^2). Annual working time was calculated by multiplying the number of working months in the past year by 4.35 (average number of weeks per month), and then multiplying the number of working days per week by the number of working hours per day during the past year. Information was obtained using a face-to-face survey. Agricultural classification was divided into rice farming, field farming (field crops, facility crops, fruit tree, and livestock) according to mechanization rate. The χ^2 test and Cochran-Armitage test for trend were performed using Medcalc version 20.015 (Medcalc Software, Mariakerke, Belgium) to examine differences in the prevalence of OA in each finger joint and dose-response relationships between risk factors and hand OA prevalence. Robust Poisson regression were performed to evaluate the relationship between hand OA and occupational risk factors using IBM SPSS version 22.0 (IBM Corporation, Armonk, NY, USA). The p-values of < 0.05 were considered statistically significant.

Ethics statement

The Institutional Review Board of Chosun University Hospital approved this study protocol (CHOSUN202007017-HE001). Written informed consents was obtained from all participants.

RESULTS

The participants' characteristics are presented in **Table 1**. This study included 310 women farmers with the mean age of 58.1 ± 7.6 years (median, 58; range, 29–77). BMI (p = 0.456) and annual working time (p = 0.110) values were comparable among the age groups.

Table 1. Participant characteristics, stratified by age (n = 310)

Variable	< 60 years (n = 176)	≥ 60 years (n = 134)	Total (n = 310)	p-value
BMI (kg/m^2)				0.456
< 25	91 (51.7)	75 (56.0)	166 (53.5)	
≥ 25	85 (48.3)	59 (44.0)	144 (46.5)	
Mean ± SD	25.3 ± 3.4	25.1 ± 3.0	25.2 ± 3.3	0.564[a]
Annual working time (hour/year)				0.110
< 2,000	78 (44.3)	60 (44.8)	138 (44.5)	
2,000–2,999	52 (29.5)	51 (38.1)	103 (33.2)	
≥ 3,000	46 (26.1)	23 (17.2)	69 (22.3)	
Mean ± SD	2,295.9 ± 1,158.6	2,154.3 ± 953.1	2,234.7 ± 1,075.2	0.239[a]
Agricultural classification				0.468
Rice farming	94 (53.1)	66 (49.3)	160 (51.6)	
Field farming	82 (46.6)	68 (50.7)	150 (48.4)	

Values are presented as number (%). The p-values were derived with the χ^2 test.
BMI: Body mass index; SD: standard deviation.
[a]The p-value derived from 2 sample t-test.

The rates of OA in the IP1, DIP, and PIP joints were in the range of 27.4%–32.3%, 7.4%–14.8%, and 0.6%–4.5%, respectively (**Fig. 1**). OA was most and least prevalent in the thumb and fourth finger joints, respectively; the corresponding values for the second, third, and fourth finger joints were comparable (**Fig. 2**). The prevalence of the right hand was high overall, but it was not statistically significant (*p* for trend = 0.06). Only the second and fourth fingers showed a statistically significant difference (**Fig. 3**).

The prevalence of hand OA among the present study participants was 49.0%. In participants aged < 60 and ≥ 60 years, these rates were 34.7% and 67.9%, respectively, with a statistically significant age-dependent increase (*p* < 0.001). In addition, as the average number of annual working hours increased, the prevalence of hand OA increased to 41.3% at < 2,000 hours per year, 53.4% at 2,000–2,999 hours per year, and 58.0% at ≥ 3,000 hours per year (*p* for trend
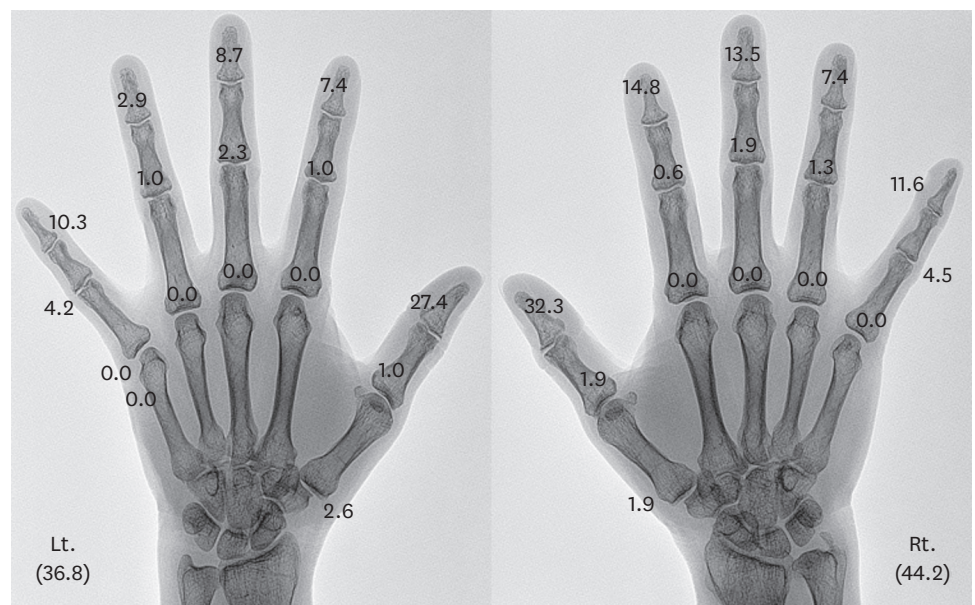

Fig. 1. Prevalence (%) of radiographic hand osteoarthritis at the joint level.
Lt.: left hand osteoarthritis of any joint prevalence; Rt.: right hand osteoarthritis of any joint prevalence.
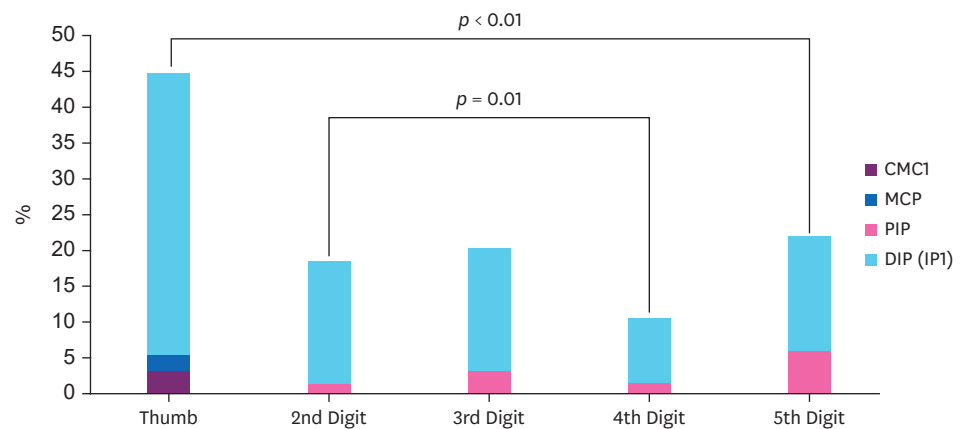

Fig. 2. Osteoarthritis prevalence by finger of each hand. The *p*-values were derived with the χ^2 test. The IP joint of the thumb is marked together with the DIP joint.
CMC1: carpometacarpal joint in the thumb; MCP: metacarpophalangeal joint; PIP: proximal interphalangeal joint; DIP (IP1): distal interphalangeal joint (interphalangeal joint in the thumb).
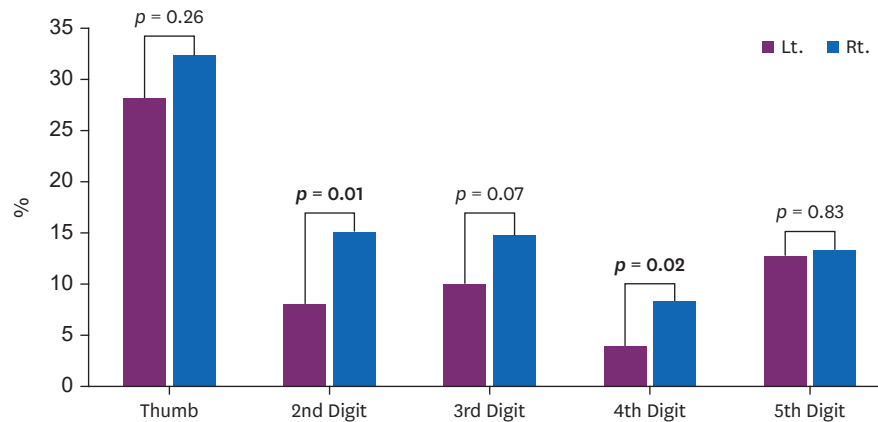
Fig. 3. Left and right osteoarthritis patterns at the joint level. The p-values were derived with the χ^2 test. Lt.: left hand; Rt.: right hand.

Table 2. Prevalence of hand OA

Variables	Hand OA		IP1 OA	
	%	p-value	%	p-value
Age (years)		< 0.001		< 0.001
< 60	34.7		27.3	
≥ 60	67.9		55.2	
BMI (kg/m²)		0.317		0.214
< 25	46.4		36.1	
≥ 25	52.1		43.1	
Annual working time (hour/year)		0.015[a]		0.025[a]
< 2,000	41.3		31.2	
2,000–2,999	53.4		46.6	
≥ 3,000	58.0		44.9	
Agricultural classification		0.005		< 0.001
Rice farming	41.3		30.0	
Field farming	57.3		49.3	
Total	49.0		39.4	

The p-values were derived with the χ^2 test.
OA: osteoarthritis; IP1: interphalangeal joint in the thumb; BMI: body mass index.
[a]The p-value by Cochran-Armitage test for trend.

= 0.015). According to the agricultural classification, the prevalence in rice farming and field farming were 41.3% and 57.3%, respectively, indicating a statistically significant difference (p = 0.005). Obesity did not associate with the prevalence of hand OA. The hand OA and IP1 OA prevalence followed similar trends and associations with age, annual working time, and agricultural classification (**Table 2**).

Risk factors

Table 3 presents the results of Poisson regression with robust standard errors of risk factors for the hand and IP1 OA prevalence. In the overall sample, age and hand OA prevalence showed correlations. Prevalence ratio (PR) of OA for the age groups of ≥ 60 years (PR = 1.96, 95% confidence interval [CI]: 1.55–2.48) were calculated using the age group of < 60 years as a comparison group. The adjusted PR (APR) by BMI, working time, and agricultural classification of OA for the age groups of ≥ 60 years (APR = 2.01, 95% CI: 1.60–2.53) were calculated using the age group of < 60 years as a comparison group. BMI did not relate the prevalence of hand OA in the present study. Annual working time ≥ 3,000 hours per year was associated with the prevalence of hand OA (PR = 1.40, 95% CI: 1.06–1.86). The result was consistent with APR (1.49, 95% CI: 1.14–1.94) adjusted for age, BMI, and agricultural

Table 3. Poisson regression with robust standard errors of potential risk factors for OA

Variables	Hand OA				IP1 OA			
	Crude		Adjusted		Crude		Adjusted	
	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI
Age (years)								
< 60	1.00		1.00		1.00		1.00	
≥ 60	1.96	1.55–2.48	2.01	1.60–2.53	2.02	1.52–2.69	2.06	1.55–2.72
BMI (kg/m²)								
< 25	1.00		1.00		1.00		1.00	
≥ 25	1.12	0.90–1.41	1.18	0.95–1.45	1.19	0.90–1.57	1.25	0.96–1.61
Annual working time (hours/year)								
< 2,000	1.00		1.00		1.00		1.00	
2,000–2,999	1.29	0.99–1.69	1.20	0.94–1.55	1.50	1.08–2.07	1.37	1.01–1.85
≥ 3,000	1.40	1.06–1.86	1.49	1.14–1.94	1.44	1.01–2.07	1.52	1.08–2.14
Agricultural classification								
Rice farming	1.00		1.00		1.00		1.00	
Field farming	1.64	1.23–2.19	1.31	1.05–1.63	1.39	1.10–1.75	1.53	1.16–2.01

Adjusted prevalence ratio; age, BMI, annual working time, agricultural classification.
OA: osteoarthritis; CI: confidence interval; IP1: interphalangeal joint in the thumb; BMI: body mass index; PR: prevalence ratio.

classification. Working with the field farming was associated with increased rates of hand OA (PR = 1.64, 95% CI: 1.23–2.19; APR = 1.31, 95% CI: 1.05–1.63).

In the IP1 joint, age and OA rates showed a relationship (PR = 2.02, 95% CI: 1.52–2.69). This result was similar pattern of adjusted model (APR = 2.06, 95% CI: 1.55–2.72). In the overall model, obesity was not associated with the rates of IP1 OA. Annual working time was associated with the rates of the IP1 OA (APR = 1.37, 95% CI: 1.01–1.85 for 2,000–2,999 hours per year; APR = 1.52, 95% CI: 1.08–2.14 for ≥ 3,000 hours per year). Working with the field farming was associated with increased rates of IP1 OA (PR = 1.39, 95% CI: 1.10–1.75; APR = 1.53, 95% CI: 1.16–2.01).

DISCUSSION

In the present study, the prevalence of OA in the right thumb was highest among women farmers, and higher than that among other joints in both hands. In addition, the prevalence of OA was higher in the right than in the left hand. The risk of hand OA increased with age and working time. Furthermore, the risk of hand OA increased among women farmers working with field farming than among those working with rice farming.

The prevalence of hand OA among the study participants was 49.0%. This prevalence is lower than the 58.0% prevalence of radiologic hand OA among 460 Korean fruit tree farmers with average age of 59.7 years, found in a study by Kim et al.[32] However, the prevalence of IP1 OA of 39.0% was higher than that found in some previous studies. The study using the Framingham cohorts included 1,300 women (mean age 58.9 ± 9.9 years) and reported the prevalence of 50.5%, based on the same radiographic criteria.[31] However, the prevalence of IP1 OA was only 15.8%. Moreover, a follow-up study of 118 patients that underwent an isolated unilateral meniscectomy 10 years beforehand revealed an increase in the prevalence of hand OA from 36.0% to 53.0%. However, the prevalence of IP1 OA increased from 9% to 12%.[30] Cooney et al.[33] reported that during grasping, the compression force of the IP1 joint dramatically increased, likely acting on the articular surface of the IP1 joint. In the second and fourth fingers, the prevalence of OA was significantly higher in the right hand compared with the left hand. We presume that this difference is related to the working method of holding

crops with the left hand and manipulating the crops with the right hand during agricultural work. Caspi et al.[17] reported that the dominant hand, which was used more frequently, had a higher hand OA score in the hand except for the CMC1 joint; these findings suggest that the rates of OA increase with increased hand use. In this study, dominant hand was not directly investigated. Approximately 6% of the Korean population is left-handed.[34] Therefore, we emphasize that the misclassification can underestimate the difference if the right hand is regarded as a dominant hand.

In fingers 2–5, the prevalence of OA was higher in the DIP joint than in the PIP and MCP joints. These findings are consistent with those of previous studies.[4,30,35,36] The reason for the higher prevalence of OA in the DIP joints, is unknown. The prevalence of DIP OA differs according to intrinsic factors such as genetics, gender, and ethnicity.[37] Biomechanical studies have provided no evidence that the joint force is greater in DIP than in PIP during pinch or grip,[38] but an MRI study has shown a high prevalence of thickened collateral ligaments in DIP OA,[39] suggesting that the relatively high prevalence of DIP OA may be because the DIP joint has a higher chance of ligament damage than the PIP joint.

The risk of hand OA increased rapidly in women farmers aged ≥ 60 years. This finding is consistent with that of previous studies,[2,5,19] investigating the risk of hand OA according to age. Age is a major risk factor for hand OA. The present study showed the trend of association between obesity and the rate of hand OA, but was not statistically significant. Yusuf et al.[40] systematically reviewed 26 studies on the association between BMI and hand OA. A total of 16 studies showed a significant association between obesity and OA; in addition, a moderate level of association was suggested based on 3 high-quality studies. We estimated that insignificant association resulted from a small sample size.

Working hours associated with the rates of hand OA in the present study. Among women farmers declaring ≥ 3,000 hour working hours per year, an APR for hand OA was 1.49 (95% CI: 1.14–1.94) (comparison group: women farmers working < 2,000 hours per year Although prolonged stress may increase the risk of OA, few studies have examined this relationship, precluding any meaningful comparison of the present and previous findings. The association between the agricultural classification and the prevalence of OA was statistically significant. In the supplementary analysis with agricultural classification divided into 5 groups, IP1 OA was strongly associated with field farming (**Supplementary Table 1**). In the subgroup analysis by age, the PR was higher in those aged ≥ 60 years than in those aged < 60 years in the field farming group (**Supplementary Tables 2** and **3**). The mechanization rate of Korean agriculture is estimated at 98% for rice farming and 56% for field farming.[41] A lower mechanization rate means that field farming requires more manual work. The low mechanization rate may account for the high prevalence of hand OA and IP1 OA among field farmers.

This study has several limitations. First, this was a cross-sectional study, and the present findings are low-level evidence, precluding any meaningful discussions about causality. Second, radiological hand OA, the outcome variable of present study, is different from the symptomatic hand OA diagnosed the real clinic field. Third, radiological hand OA is the result of lifetime exposure to ergonomic hazards. However, the annual working time only means exposure over the recent year. In present study, annual working time is only a proxy indicator of lifetime exposure, and it is difficult to accurately confirm the correlation with actual lifetime exposure. Fourth, we have not investigated non-occupational ergonomic factors such as housework and hobbies. Housework can act as a hidden factor in hand OA,

especially in women. Fifth, the selection of the participants as conducted using a purposive sampling. This method can select women farmers who are actively engaged in actual farming, but it is possible that those who are interested in health have been selected. Sixth, 2 occupational physicians read the radiographic images instead of radiologists. The result of the consistency evaluation was satisfactory.

CONCLUSIONS

The present findings suggest that OA in women farmers is predominantly IP1 and DIP joints. The prevalence of OA in the present study was comparable to that previously reported; however, the prevalence of IP1 OA was higher in the present than in the previous studies. In particular, the rates of thumb OA were positively associated with long working time and specific farming types. Unlike age, work-related risk factors for OA are modifiable. Repetitive and exertional grip use in women farmers should be lowered to reduce the risk of OA.

ACKNOWLEDGEMENTS

SUPPLEMENTARY MATERIALS

Supplementary Table 1
Robust Poisson regression of potential risk factors for OA: 5 type agricultural classification

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Supplementary Table 2
Robust Poisson regression of potential risk factors for OA: < 60 years age group

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Supplementary Table 3
Poisson regression with robust standard errors of potential risk factors for OA: ≥ 60 years age group

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