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# Functional index for hand osteoarthritis (FIHOA) is associated with pain, muscle strength, and EQ-5D in hand osteoarthritis

Seong-Kyu Kim , Ui Hong Jung and Jung-Yoon Choe

## Abstract

**Background:** This study identified whether Functional Index for Hand Osteoarthritis (FIHOA) is associated with pain, hand muscle strength, health-related quality of life, and radiographic severity in hand osteoarthritis (OA).

**Methods:** We consecutively recruited 95 patients with hand OA. The FIHOA was used to assess questionnaire-based physical function in hand OA. Health-related quality of life was evaluated using EuroQol-5 dimension (EQ-5D). Radiographic changes of hand joints were measured by Kellgren-Lawrence (K-L) grade, which was determined based on total radiographic severity score and number of affected joints. Other measures included patient's visual analogue scale (VAS) score for pain and performance-based function indexes such as grip and pinch strength. Statistical analysis was performed using Mann-Whitney U test, Spearman's correlation analysis, and multivariate logistic regression analysis.

**Results:** FIHOA score was negatively associated with grip and pinch hand strength and EQ-5D and positively correlated to VAS pain ( $p < 0.05$  for all). There were significant differences of grip and pinch strength, VAS pain, EQ-5D index, and EQ-VAS between two FIHOA groups ( $\leq 4$  vs.  $> 4$ ) ( $p < 0.05$  for all). Multivariate logistic regression analysis showed that higher FIHOA score (FIHOA  $> 4$ ) was related with increased VAS pain and with lower EQ-5D index ( $p = 0.008$  and  $p = 0.013$ , respectively). There was no association between FIHOA score and measures of total radiographic severity score and number of affected joints.

**Conclusion:** This study observes that FIHOA score is associated with patient-reported VAS pain, hand muscle strength indexes, and EQ-5D but not radiographic severity in hand OA.

**Keywords:** Osteoarthritis, Hand, FIHOA, EQ-5D, VAS, Kellgren-Lawrence grade

## Background

Hand osteoarthritis (OA) is a prevalent degenerative disease that leads to pain, joint deformity, functional disability, and impaired quality of life [1, 2]. The clinical phenotypes of hand OA seem to be heterogeneous according to number and pattern of joint involvement. The Outcome Measures in Rheumatology (OMERACT) and the Osteoarthritis Research Society International (OARSI) Task Force on Clinical Trials Guidelines have

been frequently used in clinical trials [3, 4]. For assessment of physical function based on a questionnaire for hand OA, outcome measures from the pain subscale of the Australian/Canadian (AUSCAN) Index [5], the Cochin hand functional disability scale [6], and the Functional Index for Hand Osteoarthritis (FIHOA) [7] have been used in clinical trials and have been shown to be valid, reliable, and relevant.

The FIHOA is a unidimensional questionnaire that is structurally different from the AUSCAN index, which measures pain, stiffness, and function dimensions [7, 8]. A case-control study revealed that FIHOA score was gradually increased as the severity of hand OA increased [9].

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In a study that analyzed 18 patients with hand OA, FIHOA score was found to be correlated with the degree of radiological damage, but not synovial inflammation based on magnetic resonance image (MRI) [10]. Compatible with previous studies [7, 8], Koutroumpas et al. confirmed significant association between FIHOA and clinical assessment for erosive hand OA [11]. In addition, FIHOA was noted to be related with MRI-defined bone attrition in 77 female patients with hand OA [12]. However, there is a lack of research data regarding FIHOA score and hand muscle strength or quality of life in hand OA. The main aim of this study is to determine association of FIHOA-based functional status with pain, grip and pinch strength, quality of life, and radiographic severity in hand OA.

## Subjects and methods

### Study population

A total of 95 patients with Korean hand OA that met the American College of Rheumatology (ACR) classification criteria was recruited from the Rheumatology Clinic and enrolled in this study from February 2019 to January 2020 [13]. All patients showed radiographic changes at more than one of both hand joints assessed according to the Kellgren-Lawrence (K-L) grading system [14]. This study excluded patients diagnosed with rheumatoid arthritis, systemic lupus erythematosus, psoriatic arthritis, and gouty arthritis.

### Clinical information

Demographic data were age (years), sex, body mass index (BMI,  $\text{kg}/\text{m}^2$ ), systolic blood pressure (SBP, mmHg), diastolic blood pressure (DBP, mmHg), and symptom duration (months) at time of enrollment. Acute phase reactants, such as erythrocyte sediment rate (ESR) and C-reactive protein (CRP), were measured. Pain was scored using a 100 mm Visual Analogue Scale (VAS). The Functional Index for Hand Osteoarthritis (FIHOA) questionnaire was assessed for hand physical function scores from 0 to 30 and was composed of 10 doctor-administered questions with semi-quantitative assessment on a 4-point Likert scale ranging from 0 to 3 [7, 8]. This study used a Korean version of the FIHOA, which was validated in Korean patients with hand OA [15]. FIHOA scores were divided into two groups based on four points (FIHOA  $\leq 4$  vs. FIHOA  $> 4$ ) according to classification by an earlier study [7].

### EuroQol-5 dimension (EQ-5D) measurement

The Korean version of EQ-5D is a tool to measure health-related quality of life (HRQOL) [16]. The EQ-5D consists of the EQ-5D index and the EQ-VAS. The EQ-5D index consists of five questions that ask about the current state of health as mobility, self-care, usual activities, pain/discomfort, and anxiety/depression.

### Radiological assessment

Total radiographic severity scores were the sum of Kellgren-Lawrence (K-L) grade scores at a total of 20 joints such as 2nd – 5th distal interphalangeal (DIP) joints, 2nd – 5th proximal interphalangeal (PIP) joints, thumb interphalangeal (IP) joint, and first carpometacarpal joint of both hands, which ranged from grade 0 to grade 80. The number of affected joints with any kind of radiologic change was calculated for each subject according to the K-L grading system. A single rheumatologist completing a training program (UH Jung) provided radiographic digital images of hand joints from the Korean College of Rheumatology.

### Muscle strength measurement

Measurement for grip strength in both hands was performed with arms and elbows at right angles using a dynamometer (Jamar Hydraulic Hand Dynamometer, Nottinghamshire, UK). Pinch strength for the first and second fingers was measured by a pinch gauge (B&L Engineering, Tustin, CA, USA). The mean values for grip strength and pinch strength were presented after measurements on both hands.

### Statistical analysis

Data are described as median (interquartile range [IQR]) for continuous variables and number (percentage [%]) for nominal variables. The Shapiro-Wilk test was applied to test normality and showed a non-normal distribution. The correlations between FIHOA score and clinical and radiographic variables were measured by Spearman's correlation coefficient. The differences of variables between FIHOA  $\leq 4$  and FIHOA  $> 4$  were calculated by Mann-Whitney U test. Multivariate logistic regression analysis was performed to identify clinical and radiographic variables related to higher FIHOA score  $> 4$  along with the odds ratio (OR) and 95% confidence interval (CI). A *P* value less than 0.5 was considered statistically significant. Statistical analyses were performed by IBM SPSS Statistics 19.0 (IBM Corp., Armonk, NY, USA).

## Results

### Baseline characteristics

Baseline characteristics of enrolled subjects are described in Table 1. The median age was 60.0 years (IQR 54.0–66.0), and most subjects were female ( $n = 90$ , 94.7%). The average values of grip strength and pinch strength were 20.0 (IQR 16.5–24.5) and 5.7 (IQR 4.8–6.5), respectively, and the median score of FIHOA was 65.0 (IQR 50.0–80.0). Radiographic changes were measured as 6.0 (IQR 2.0–18.0) for total radiographic severity score and 5.0 (IQR 2.0–9.0) for affected joint count.

**Table 1** Baseline characteristics of enrolled subjects

Variables	Results
Age (year)	60.0 (54.0–66.0)
Sex, female (n, %)	90 (94.7)
Symptom duration (month)	6.0 (1.0–73.0)
BMI (kg/m <sup>2</sup> )	23.4 (21.5–24.9)
SBP (mmHg)	127.0 (115.0–135.0)
DBP (mmHg)	74.0 (69.0–80.0)
ESR (mm/hr)	14.0 (9.0–32.0)
CRP (mg/L)	0.6 (0.6–0.8)
Past history	
Hypertension (n, %)	24 (25.3)
Diabetes mellitus (n, %)	10 (10.5)
Grip strength	
Mean <sup>a</sup>	20.0 (16.5–24.5)
Right	20.0 (16.0–25.0)
Left	22.0 (16.0–25.0)
Pinch strength	
Mean <sup>a</sup>	5.7 (4.8–6.5)
Right	6.0 (5.0–6.8)
Left	5.5 (4.8–6.5)
VAS pain	34.0 (20.0–52.0)
FIHOA	65.0 (50.0–80.0)
EQ-5D index	0.82 (0.77–0.87)
EQ-VAS	65.0 (50.0–80.0)
Total radiographic severity scores (0–80) <sup>b</sup>	6.0 (2.0–18.0)
Number of affected joints (0–20) <sup>b</sup>	5.0 (2.0–9.0)

Data were described as median (Interquartile range) or number (%)

Abbreviation: BMI body mass index; SBP systolic blood pressure; DBP diastolic blood pressure; ESR erythrocyte sedimentation rate; CRP C-reactive protein; VAS visual analogue scale; FIHOA Functional Index for Hand Osteoarthritis; EQ-5D EuroQol-5 dimension

<sup>a</sup>Average value of the sum of right and left hand scores

<sup>b</sup>Based on Kellgren-Lawrence grade

### Comparison of variables according to FIHOA group

There were no differences in age, sex, symptom duration, BMI, SBP, DBP, ESR, CRP, total radiographic severity score, and number of affected joints between the high and low FIHOA groups ( $p > 0.05$  for all) (Table 2). Subjects with high FIHOA score had lower grip and pinch hand strength, higher patient VAS pain score, and lower EQ-5D index and EQ-VAS scores ( $p < 0.05$  for all).

### Associations between FIHOA score and variables

Analysis for variables related with FIHOA score showed that the score was negatively associated with mean grip and pinch hand muscle strengths, EQ-5D index, and EQ-VAS (Fig. 1). In contrast, FIHOA score was positively related with patient VAS pain. However, there were no relationships between FIHOA score and age,

sex, symptom duration, BMI, SBP, DBP, ESR, CRP, total radiographic severity score, or number of affected joints.

### Variables associated with high FIHOA score

Mean grip and pinch strength, patient VAS pain, EQ-5D index, and EQ-VAS were associated with high FIHOA score in univariate regression analysis (Table 3). Multivariate regression analysis after adjusting for confounding factors of age, sex, and symptom duration revealed that high FIHOA score was significantly linked to patient VAS pain and EQ-5D index ( $p = 0.008$  and  $p = 0.013$ , respectively).

### Discussion

This study assessed the relationships of FIHOA score with other outcome measures including pain, grip and pinch hand strength, and EQ-5D in hand OA. In addition, correlation between functional impairment and radiographic damage was also explored. We found that FIHOA score was associated with patient-reported pain, hand strength, and quality of life based on the EQ-5D in hand OA. In addition, higher FIHOA score was associated with higher VAS pain score and lower EQ-5D index and EQ-VAS. However, there was no relationship between FIHOA score and radiographic outcome.

The outcome measures of hand OA include pain, hand physical function, and quality of life [3, 4]. Among the several hand OA-specific measures for physical disability that have been developed, such as the AUSCAN Index [5], the Cochin hand functional disability scale [6], and the FIHOA [7], FIHOA score is a unidimensional measure for functional impairment of hand OA and is considered a feasible and valid questionnaire commonly used in clinical study. Efforts have been made to verify the association between FIHOA score and other measures in OA. The Health Assessment Questionnaire (HAQ) [17], which is a rheumatoid arthritis-specific questionnaire for health status, was significantly associated with FIHOA score in hand OA ( $r = 0.73$ ) and physical function scale of AUSCAN ( $r = 0.80$ ) [18]. Similarly, EQ-5D, which is a generic measure for health-related quality of life [16], was also validated in patients with knee OA, showing a negative relationship of the Korean version of Western Ontario and McMaster Scale (KWO-MAC) with the EQ-5D index [19]. There is a lack of data on the association between FIHOA score and EQ-5D in hand OA. As far as we know, this study is the first to find FIHOA score to be negatively related with EQ-5D index and EQ-VAS, and patients with high FIHOA score showed a trend toward a lower EQ-5D index but not EQ-VAS in hand OA. Based on these observations, functional impairment might be linked to health-related quality of life in hand OA.

**Table 2** Comparison of variables according to FIHOA

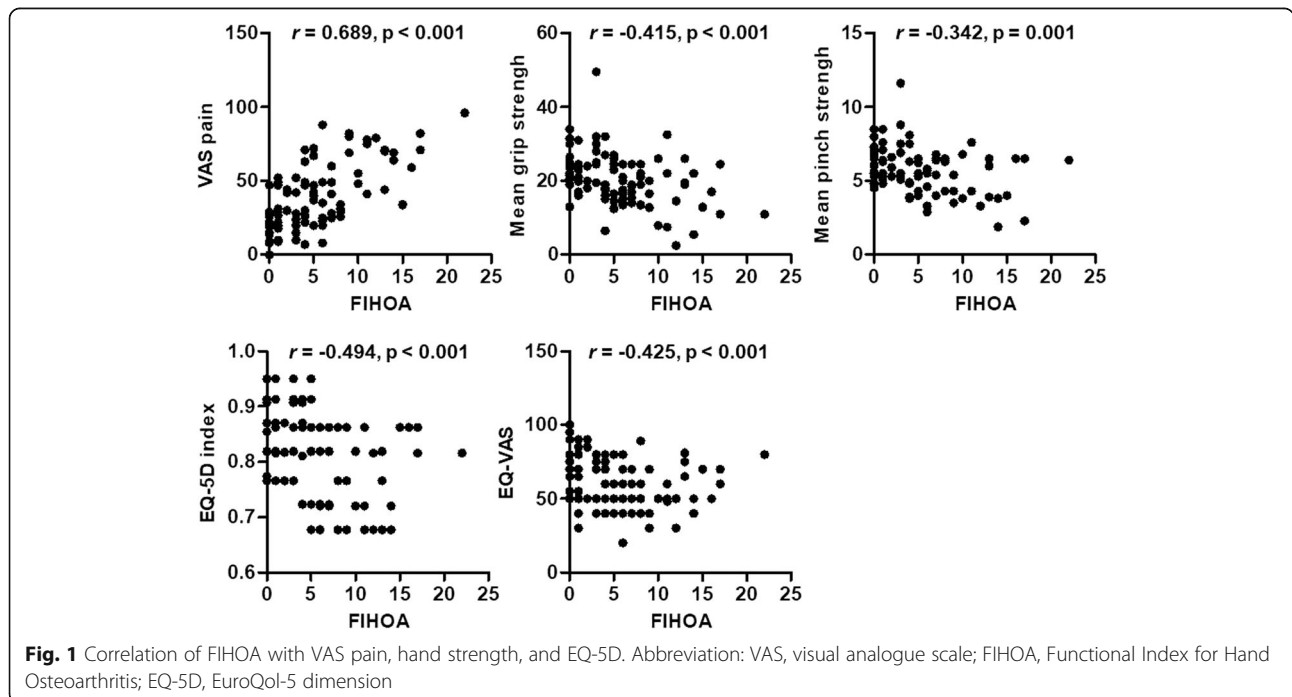
	FIHOA ≤4 (n = 49)	FIHOA > 4 (n = 46)	p values
Age (year)	61.0 (54.6–67.5)	59.0 (54.0–63.3)	0.367
Sex, female (n, %)	46 (93.9)	44 (95.7)	0.530
Symptom duration (month)	24.0 (1.0–96.0)	4.0 (1.0–30.0)	0.120
BMI (kg/m <sup>2</sup> )	23.4 (21.3–24.0)	23.8 (21.5–25.9)	0.295
SBP (mmHg)	126.0 (114.0–135.0)	127.5 (119.5–135.5)	0.690
DBP (mmHg)	74.0 (69.0–80.0)	75.5 (69.5–80.3)	0.463
ESR (mm/hr)	14.0 (9.0–27.3)	14.0 (8.0–20.5)	0.376
CRP (mg/L)	0.6 (0.6–0.8)	0.6 (0.6–1.3)	0.295
Grip strength			
Mean <sup>a</sup>	23.0 (19.3–25.0)	18.0 (13.9–22.3)	< 0.001
Right	22.0 (18.0–27.5)	18.0 (14.0–22.5)	0.004
Left	23.0 (10.0–26.0)	17.5 (12.8–23.0)	< 0.001
Pinch strength			
Mean <sup>a</sup>	6.3 (5.3–7.1)	5.4 (4.0–6.4)	< 0.001
Right	6.3 (5.1–7.3)	5.5 (3.5–6.5)	0.001
Left	6.0 (5.0–7.0)	5.5 (3.9–6.0)	0.002
VAS pain	22.0 (10.0–36.5)	48.5 (34.0–71.0)	< 0.001
EQ-5D index	0.87 (0.82–0.91)	0.82 (0.7–0.86)	< 0.001
EQ-VAS	70.0 (57.5–80.0)	50.0 (49.5–70.0)	< 0.001
Total radiographic severity scores <sup>b</sup>	6.0 (2.5–21.0)	8.5 (2.0–17.3)	1.000
Number of affected joints <sup>b</sup>	5.0 (2.0–12.0)	5.5 (2.0–9.0)	0.917

Data were described as median (Interquartile range) or number (%)

Abbreviation: *BMI* body mass index; *SBP* systolic blood pressure; *DBP* diastolic blood pressure; *ESR* erythrocyte sedimentation rate; *CRP* C-reactive protein; *VAS* visual analogue scale; *FIHOA* Functional Index for Hand Osteoarthritis; *EQ-5D* EuroQol-5 dimension

<sup>a</sup>Average value of the sum of right and left hand scores

<sup>b</sup>Based on Kellgren-Lawrence grade



**Table 3** Determination of variables related with high FIHOA score

Variables	Univariate regression			Multivariate regression		
	OR	95% CI	p values	OR	95% CI	p values
Age (year)	0.978	0.934–1.025	0.362	0.940	0.864–1.022	0.149
Sex, female (n, %)	0.697	0.111–4.372	0.700	1.919	0.128–28.793	0.637
Symptom duration (month)	0.995	0.988–1.001	0.111	0.988	0.976–1.001	0.078
BMI (kg/m <sup>2</sup> )	1.060	0.900–1.226	0.535			
ESR (mm/hr)	0.974	0.939–1.009	0.146			
CRP (mg/L)	1.137	0.856–1.512	0.375			
Mean grip strength	0.871	0.803–0.945	0.001	0.907	0.794–1.037	0.152
Mean pinch strength	0.525	0.368–0.748	< 0.001	0.803	0.445–1.448	0.466
Patient VAS	1.066	1.038–1.096	< 0.001	1.044	1.011–1.079	0.008
EQ-5D index	0.000	0.000–0.001	< 0.001	0.000	0.000–0.069	0.013
EQ-VAS	0.947	0.921–0.974	< 0.001	0.970	0.931–1.011	0.149
Total radiographic severity scores	0.996	0.963–1.030	0.815			
Number of affected joints	0.988	0.913–1.070	0.773			

Abbreviation: BMI body mass index; ESR erythrocyte sedimentation rate; CRP C-reactive protein; VAS visual analogue scale; EQ-5D EuroQol-5 dimension

It has been previously demonstrated that FIHOA score was relatively well associated with radiographic damages in hand OA [9, 10, 20, 21]. In assessment of correlation between hand functional limitation by AUSCAN function and FIHOA score and radiographic damage, FIHOA score was better correlated with radiographic structural changes than was the AUSCAN index [21]. FIHOA scores revealed larger physical disability in patients with erosive OA compared to those with non-erosive hand OA [20]. In addition, number of radiographic remodeled joints was markedly associated with FIHOA score in erosive OA. Number of joints with radiographic damage was shown to be a predictor of functional impairment ( $\beta = 0.54$ , 95% CI 0.24–0.84,  $p < 0.01$ ). Compatible with these studies, radiographic severity determined by the Kellgren-Lawrence scale was significantly associated with FIHOA score [9, 10]. However, this study observed lack of association between radiographic outcomes such as total radiographic severity score and number of affected joints and FIHOA score. Similarly, Roux et al. showed that FIHOA score was not associated with number of OA joints with K-L grade  $\geq 2$ , Verbruggen score, or osteophytes in Kallman score [10]. Ultrasound is a musculoskeletal imaging tool with many advantages over radiography in reliable and reproducible detection of intra- and extra-articular structural abnormalities, such as joint effusion, synovitis, bone erosions, and therapeutic monitoring in arthritis [22]. There is a close relationship between radiographic features and ultrasound findings [23]. However, FIHOA and AUSCAN scores were not associated with ultrasound findings [11, 24]. Important clinical questions about the relationship between functional impairment and diverse imaging tests, including conventional radiography, should be confirmed in large studies.

The VAS pain scale is frequently used to assess patient-reported pain in OA. Some studies have investigated whether physical function measures such as FIHOA and AUSCAN indexes are associated with VAS pain [11, 18]. A cross-sectional study revealed that FIHOA score was significantly associated with VAS pain and AUSCAN pain subscale ( $r = 0.51$  and  $r = 0.79$ , respectively) [18]. It has been reported that tenderness on palpation was significantly related to FIHOA score [11]. Consistently, our study confirmed a close correlation between FIHOA score and VAS pain. In addition, high FIHOA score was positively dependent on VAS pain. This suggests that FIHOA score reflects to some extent the pain in hand OA patients, although this relationship should be validated in a larger study population.

Performance-based physical function tools such as pinch and grip strength for measurement of physical function of hands have been used in clinical studies of hand OA [25]. Substantial evidence of a negative association of grip or pinch strength with AUSCAN function subscale has been noted [5, 18, 26]. Interestingly, Moe et al. demonstrated a negative relationship between mean grip strength and FIHOA score ( $r = -0.58$ ) [18]. Compatible with earlier data, the present study also found significant negative association between FIHOA score and two hand strength measures. This provides adequate evidence that there is comparable equivalence between questionnaire- and performance-based instruments in evaluating physical function of hand OA patients.

There are some limitations in this study. First, the results of this study originated from cross-sectional observation. Analysis of the causal relationships between FIHOA scores and clinical features, hand strength, and



radiologic findings is needed in prospective studies. Second, the patient reported FIHOA index does not evaluate the relevance of AUSCAN function subscale and Cochin hand function scale. The clinical, physical, and radiographic measures related to FIHOA score in hand OA need to be verified using other hand function tools such as AUSCAN and Cochin hand function scale. In addition, most of the patients in this study consisted of women. Women have higher incidence and prevalence of knee, hand, feet OA than men [27]. Especially, decreased sex hormone contributes to an increased hand OA in female [28]. Musculoskeletal function and pain in knee OA was known to be dependent on gender [29]. This suggests that pain, functional impairment and quality of life in hand OA might be different between men and women. It is necessary to evaluate whether there is gender difference of functional outcome measures such as FIHOA.

## Conclusion

This is the first observation that FIHOA score, an index for questionnaire-based physical function, is associated with EQ-5D, VAS pain, and grip and pinch strength in hand OA but not with radiographic changes. Longitudinal prospective analyses are needed to evaluate whether changes in FIHOA score are linked to those in other measures in hand OA.

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None.

## Disclosure statement

The authors do not have an actual or potential conflict of interest or not get interest of any kind to declare with regard to this work.

## Authors' contributions

SK, UHJ, and JC contributed the conception and design of the study. SK and UHJ participated in data collection. SK and JC provided substantial supervision and interpretation of the statistical analysis. SK drafted and revised the manuscript. All authors have critically read this manuscript and approved the final version.

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## Availability of data and materials

not applicable.

## Declarations

### Ethics approval and consent to participate

The Institutional Review Board approved this study (CR-20-139-L). The informed consent of all patients was waived because this study was performed by a retrospective analysis.

### Consent for publication

not applicable.

### Competing interests

The authors declare that they have no competing interests.

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