

EXTENDED REPORT

Joint-specific hand symptoms and self-reported and performance-based functional status in African–Americans and Caucasians: The Johnston County Osteoarthritis Project

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Objective: To assess associations between joint-specific hand symptoms and self-reported and performance-based functional status.

Methods: Participants were from the population-based Johnston County Osteoarthritis Project. Symptoms in the distal interphalangeal (DIP), proximal interphalangeal (PIP), first carpometacarpal (CMC), and metacarpophalangeal (MCP) joints were assessed on a 30-joint diagram of both hands. Self-reported function was assessed by Health Assessment Questionnaire (HAQ) and performance-based function by timed repeated chair stands and 8-foot walk time. Separate multiple logistic regression models examined associations between symptoms in specific hand joint groups, symptoms in ≥ 2 hand joint groups and number of symptomatic hand joints, and functional status measures, controlling for age, race/ethnicity, sex, body mass index, radiographic knee and hip OA, knee and hip symptoms and depressive symptoms.

Results: Those with symptomatic hand joint groups were more likely than those without these complaints to report more difficulty and require longer times for performance measures. Those with 2 or more symptomatic hand joint groups were more likely to have higher HAQ scores (OR = 1.97 (1.53 to 2.53)) and require more time to complete 5 chair stands (OR = 1.98 (1.23 to 3.18)) and the 8 foot walk test (OR = 1.49 (1.12 to 1.99)).

Conclusions: Joint-specific hand symptoms are associated with difficulty performing upper- or lower-extremity tasks, independent of knee and hip OA and symptoms, suggesting that studies examining functional status in OA should not ignore symptomatic joints beyond the joint site of interest, even when functional measures appear to be specific for the joint site under study.

Osteoarthritis (OA) is a common cause of pain and disability.^{1, 2} Pain, aching or stiffness attributed to hand OA is associated with functional limitations in activities requiring use of the hands.^{3, 4} Individuals with OA of both the hands and knees have higher (worse) Health Assessment Questionnaire (HAQ) scores than those with isolated hand or knee OA.⁵ Unrecognised concomitant hand symptoms could potentially confound studies using the HAQ to follow symptoms of hip or knee OA, especially since a significant number of patients with isolated hip or knee OA alone will develop hand OA over time.⁵ Despite this, investigations of the impact of upper- or lower-extremity OA traditionally use questions, functional tests or even selected components of the HAQ restricted to upper- or lower-extremity function.^{4, 6, 7} We have previously reported an association between knee pain and difficulty performing not just lower-extremity tasks but upper-extremity tasks as well, suggesting possible concomitant upper-extremity involvement in the participants in the Johnston County Osteoarthritis Project.⁸ In this study, we examined associations between joint-specific hand symptoms, as surrogate measures of hand OA, and self-reported and performance-based measures of functional status. Additionally, we evaluated whether these associations were independent of radiographic hip and knee OA and hip and knee symptoms, and whether these associations varied by race/ethnicity, sex, and the presence of knee or hip symptoms.

PATIENTS AND METHODS

Participants were selected from the baseline examination of the Johnston County Osteoarthritis Project, a population-based study of hand, hip and knee OA. Details of this study have been

reported previously.⁹ Briefly, participants were recruited by probability sampling of streets in 6 townships of the county, with oversampling of African Americans. Civilian, non-institutionalised, African American or white adults aged 45 years or older who were physically and mentally capable of completing 2 home interviews and a clinic visit, were eligible. Of those eligible, 72% completed a first interview, and 83% of those completed a subsequent clinic visit.⁹ The clinical examination included assessment of weight in kilograms using a balance-beam scale and height in centimetres, a limited joint examination, performance-based functional status and radiographic evaluation.

From the 3187 participants, 3040 were available for this analysis after excluding those with missing or outlier data for the variables of interest. Participants with radiographic evidence of an inflammatory arthropathy on knee and hip radiographs were excluded. The sample included 39% males and 32% African–Americans. The mean age (SD) was 61.0 (10.5) years.

Joint-specific hand symptoms

Joint-specific hand symptoms were assessed by asking participants to indicate on right and left hand diagrams any joint in DIP, PIP, MCP or CMC joint groups which currently gave them trouble. There was no response option for non-joint-specific hand symptoms.

Abbreviations: CMC, carpometacarpal; DIP, distal interphalangeal; HAQ, Health Assessment Questionnaire; MCP, metacarpophalangeal; OA, osteoarthritis; PIP, proximal interphalangeal

Hip and knee symptoms

Participants were asked separately for right and left hips and knees "On most days, do you have pain, aching, or stiffness in your right (left) hip (knee)?" Hip symptoms and knee symptoms were each defined as present if symptoms were reported in at least one hip or one knee, respectively.

Radiographic hip and knee OA

In order to protect women of childbearing potential from pelvic radiography, only women >50 years and men had supine anteroposterior pelvic radiography. All participants underwent bilateral anteroposterior radiography of the knees with weight-bearing. Hip and knee radiographs were graded 0–4 according to the Kellgren–Lawrence (K–L) classification scheme,¹⁰ defining OA as K–L grade ≥ 2 in at least one hip or one knee, respectively. Inter-rater reliability (assessed with another trained radiologist) and intra-rater reliability for the study radiologist were high (weighted kappa for inter-rater reliability was 0.86; kappa for intra-rater reliability was 0.89), as described previously.¹¹

Measurement of upper- and lower-extremity function

Self-reported functional status was assessed with the Stanford Health Assessment Questionnaire (HAQ) Disability Index.¹² The 20 individual functions in 8 domains (dressing, arising, eating, walking, reaching, gripping, chores and hygiene) were scored (0—with no difficulty, 1—with little difficulty, 2—only with much difficulty and 3—unable to do). Those requiring assistive devices to perform an activity were assigned a score of "2" for that activity. The highest score of the individual items for each functional group determined the score for that group. HAQ scores were computed using the average score of the 8 domains.

Performance-based functional status was assessed using timed 5 chair stands and gait over an 8-foot course.¹³ Participants were asked to rise from a chair of standard height, 5 times in succession as rapidly as comfortably possible without the use of their arms. Participants completing less than 5 stands were recorded as "unable". For participants completing 5 or more stands, the time to the nearest tenth of a second was recorded. Participants completed 2 trials of walking 8 feet at their usual walking pace, using walking aids if required, from a stationary start. Times were recorded to the nearest tenth of a second for each trial, and the 2 trial times were averaged.

Potential confounders

Other covariates included age (45–54, 55–64, 65–74, ≥ 75), sex, race/ethnicity (African–American vs Caucasian), and body mass index (BMI, weight (kg)/(height² (m²))) as a continuous variable. Depressive symptoms were reported with the Centers for Epidemiologic Studies–Depression Scale (CES-D).¹⁴

Statistical analysis

All analyses were performed using SAS version 9.1. Descriptive statistics were calculated and differences assessed by Cochran–Mantel–Haenszel statistics for categorical variables, and one-way ANOVA testing for linear trend for continuous variables such as age and BMI across the levels of HAQ score. We considered 3 functional outcomes: (1) total HAQ score categorised in 3 levels (0; greater than 0 but less than 1; and ≥ 1), (2) timed 5 chair stands and (3) timed 8-foot walk. Timed 5 chair stands was coded as a 3-level variable (<median completion time of 12 s (referent); ≥ 12 s; unable). Timed 8-foot walk was coded as a dichotomous variable setting the cutpoint at the median completion time (<3.05 s and ≥ 3.05 s).

We evaluated 5 hand joint symptom variables, coded dichotomously as present/absent: symptoms in any DIP; PIP; CMC; MCP; and 2 or more hand joint groups (PIP, DIP, CMC).¹⁵

An additional hand joint symptom variable, the number of hand joints with symptoms, was coded continuously (0–30).

Associations between hand joint symptom variables and functional status outcomes were examined in separate logistic regression models, adjusting first for age, sex, race/ethnicity and BMI, then additionally for knee and hip symptoms and radiographic knee and hip OA, and finally for CES-D score. The proportional odds assumption was tested for 3-level outcomes; if the assumption was violated, a generalised logit model was used instead. As such, a proportional odds model was used to analyse associations for the HAQ score outcome, and a generalised logit model was used for timed 5 chair stands. A proportional odds model assumes that the relationship between the independent variable of interest and levels of outcome is similar across successively more severe levels of the outcome. This process generates a single odds ratio to describe the comparison between the best category (HAQ = 0) and the 2 other categories combined, and between the best category plus the middle category, compared with the worst category. A generalised logit model generates an odds ratio for each comparison between the referent and the middle category and between the referent and the worst category.

Four 2-way interactions—between each hand joint symptom variable and (1) race/ethnicity, (2) sex, (3) hip symptoms and (4) knee symptoms—were tested jointly in each model. Adjusted p values of 0.05 or less were considered significant, and for those models with significant interactions, each individual 2-way interaction term was checked. If these individual p values were significant at the 0.05 level, then appropriate sub-groups were examined by including that interaction term in the model and calculating odds ratios and 95% confidence intervals separately for each sub-group. Adjustment for multiple comparisons was conducted using the Hochberg method for each outcome.

RESULTS

Symptoms in at least 1 hand joint were reported by 34% of participants, with nearly 3% reporting symptoms in all 30 joints. Seventeen per cent reported DIP symptoms; 20% reported PIP symptoms; 9% reported CMC symptoms; 18% reported MCP symptoms; and 12% reported symptoms in 2 or more hand joint groups. Hip symptoms were reported by 36% and knee symptoms by 44%. Difficulty performing at least one HAQ activity was reported by 41% of the participants; more than 8% were unable to perform the timed 5 chair stands, and the median completion time for 8 foot walk was 12 s.

Those with higher HAQ scores were more likely to be older individuals or women, to have a higher mean BMI, to have radiographic hip or knee OA, or to report hip or knee symptoms or more depressive symptoms (table 1). These same characteristics were seen in those requiring longer times to complete the timed 5 chair stands and timed 8-foot walk (data not shown). In addition, those requiring longer times for these performance-based outcomes were more likely to be African American ($p < 0.0001$).

In adjusted models, those with one or more symptomatic DIP, PIP, MCP or CMC joints were 50–70% more likely, and those with 2 or more hand joint groups with symptoms were twice as likely, as those without these complaints to have higher total HAQ scores (table 2). For the most part, the crude estimates for the associations between joint-specific hand symptoms and HAQ scores were attenuated by adjustment for demographics and BMI; further adjustment for hip and knee symptoms and radiographic OA was associated with the greatest attenuation of the estimates, with lesser impact on the estimates associated with additional adjustment for depressive symptoms (Table 2).

Table 1 Characteristics of the study sample according to Health Assessment Questionnaire (HAQ) categories

Covariate	HAQ=0	0>HAQ<1	HAQ≥1	p value
Mean age (SD)	59.9 (10.1)	62.2 (10.7)	63.5 (11.4)	<0.0001
Age groups (%)				
45 to <55	36.5	29.7	28.3	<0.0001
55 to <65	30.0	28.0	25.3	
65 to <75	24.9	28.5	24.3	
75+	8.6	13.8	22.1	
% African-American	30.8	29.9	37.1	0.0636
% women	54.6	64.5	78.1	<0.0001
Mean BMI (SD)*	28.2 (5.3)	29.4 (6.2)	31.1 (7.2)	<0.0001
% radiographic hip OA*	24.8	31.9	39.9	<0.0001
% radiographic knee OA†	24.4	33.2	45.9	<0.0001
% hip symptoms†	21.1	50.9	69.5	<0.0001
% knee symptoms†	25.7	62.6	83.0	<0.0001
Median CES-D score (range)*‡	2 (0 to 40)	6 (0 to 47)	10 (0 to 51)	<0.0001

*Radiographic OA based on Kellgren–Lawrence grade ≥2; †hip symptoms and knee symptoms were pain, aching, or stiffness in at least one hip (knee) on most days; ‡Centers for Epidemiologic Studies—Depression Scale.

Joint-specific hand symptoms were also associated with performance-based functional status (table 3), with similar patterns of association and confounding to those seen with the HAQ scores outcome. Those with symptomatic DIP, PIP, CMC, MCP or 2 or more hand joint groups with symptoms were 40–80% more likely than those without these symptoms to require longer times to complete the timed 5 chair stands; those with symptomatic PIP, CMC, MCP or 2 or more hand joint groups with symptoms were approximately twice as likely to be unable to perform the timed 5 chair stands at all, compared with those without symptoms in these hand joint groups. For each additional hand joint with symptoms, there was a 3–4% increase in odds of requiring longer times, or being unable, to perform the timed 5 chair stands. Compared with their counterparts, those with symptoms in the DIP, PIP, or 2 or more hand joint groups were 30–50% more likely to require longer than the median time to complete the 8 foot walk. Each additional hand joint with symptoms increased the odds of requiring longer than the median time to complete the 8 foot walk by 2%.

Although there were associations that varied by race/ethnicity, sex, hip symptoms and knee symptoms, almost none of these was significant after adjustment for multiple comparisons. In those without hip symptoms, each additional hand joint with symptoms was associated with a 7% increase in odds of having higher total HAQ scores, while a borderline significant increase in odds of 1% was observed in those with hip symptoms.

DISCUSSION

We found associations between joint-specific hand symptoms and self-reported and performance-based measures of functional status, including those associated with lower-extremity

function. These associations were independent of demographic factors, BMI, hip and knee symptoms, radiographic hip and knee OA, and depressive symptoms, and were seen in both African Americans and Caucasians, and in both women and men.

Hand joint symptoms and disability represent the true impact of hand joint disease on an individual. It is not surprising that individuals reporting symptoms in the hands might also report difficulty performing tasks using the upper extremities. While this was the case in our study, we also observed associations between hand joint symptoms and HAQ questions aimed at activities primarily involving lower extremity or mixed lower and upper extremity function (data not shown). Because participants who report symptoms in the hands might be predisposed to report other joint symptoms or decreased function in general, we controlled for depressive symptoms and also tested performance-based measures of lower extremity function, perhaps less likely to be influenced by reporting bias. These results corroborated the self-reported functional measure, showing that those with joint-specific hand symptoms were more likely to have worse functional status by performance measures. The associations between all affected hand joint sites and decreased ability to perform these functional lower extremity tasks suggest that joint-specific hand symptoms are related to an overall or “systemic” decrease in physical function that goes beyond reporting of symptoms in the hand joints. It is likely that performance of tasks seemingly requiring the use of just the upper or lower extremities is more complex and requires good function of the entire musculoskeletal system, as has been suggested for hand function and ability to climb stairs or rise from a chair.⁴

Primary OA is a generalised musculoskeletal condition whose hallmark is hand OA; joint pathology at other sites may in some

Table 2 Adjusted odds ratios and 95% confidence intervals for associations between joint-specific hand symptoms and Health Assessment Questionnaire score categories*

	DIP symptoms	PIP symptoms	CMC symptoms	MCP symptoms	≥2 hand joint groups with symptoms	No. of hand joints with symptoms
Crude	2.41 (2.01, 2.89)	2.62 (2.20, 3.11)	2.99 (2.37, 3.77)	2.63 (2.19, 3.14)	3.30 (2.68, 4.06)	1.07 (1.06, 1.08)
Adjusted 1†	2.15 (1.78, 2.59)	2.52 (2.11, 3.00)	2.63 (2.08, 3.34)	2.46 (2.05, 2.96)	3.00 (2.42, 3.70)	1.07 (1.06, 1.08)
Adjusted 2‡	1.62 (1.31, 2.01)	1.66 (1.35, 2.03)	1.57 (1.19, 2.07)	1.66 (1.35, 2.06)	1.98 (1.55, 2.53)	1.04 (1.03, 1.05)
Adjusted 3§	1.53 (1.22, 1.91)	1.61 (1.30, 1.98)	1.62 (1.22, 2.15)	1.66 (1.33, 2.06)	1.97 (1.53, 2.53)	With hip symptoms: 1.01 (0.99, 1.03) Without hip symptoms: 1.07 (1.05, 1.09)

*HAQ scores (>0 vs 0) or (≥1 vs <1); †Adjusted 1: Adjusted for age, race, sex, BMI; ‡Adjusted 2: Adjusted 1 and hip symptoms, knee symptoms, and radiographic hip and knee OA; §Adjusted 3: Adjusted 2 and CES-D score.

Table 3 Adjusted odds ratios and 95% confidence intervals for associations between joint-specific hand symptoms and functional performance measures*

	DIP symptoms	PIP symptoms	CMC symptoms	MCP symptoms	≥2 hand joint groups with symptoms	No. of hand joints with symptoms
Timed 5 chair stands						
≥12 vs <12 s	1.42 (1.10 to 1.84)	1.37 (1.08 to 1.74)	1.69 (1.18 to 2.42)	1.48 (1.14 to 1.92)	1.81 (1.33 to 2.48)	1.03 (1.02 to 1.05)
Unable vs <12 s	1.25 (0.81 to 1.92)	1.80 (1.22 to 2.65)	1.89 (1.11 to 3.20)	1.88 (1.26 to 2.82)	1.98 (1.23 to 3.18)	1.04 (1.02 to 1.07)
Timed 8 foot walk						
≥3.05 vs <3.05 s	1.31 (1.03 to 1.68)	1.33 (1.06 to 1.67)	1.18 (0.85 to 1.64)	1.21 (0.95 to 1.55)	1.49 (1.12 to 1.99)	1.02 (1.01 to 1.04)

*Adjusted for age group, sex, race/ethnicity, BMI, hip symptoms, knee symptoms, radiographic hip OA, radiographic knee OA and CES-D score.

cases be more subtle, even preradiographic, but nevertheless contribute to functional difficulties. Moreover, systemic mediators of inflammation may affect upper and lower extremities simultaneously. Finally, functional self-efficacy (a person's confidence in their ability to complete a task) is an important factor affecting functional performance as shown for people with knee OA.¹⁶ Chronic hand symptoms may influence functional self-efficacy, perhaps by contributing to depression, which has been shown to play a role in determining self-efficacy for general physical tasks.¹⁷ As above, our observations were independent of depressive symptoms.

Although hand OA is generally more common in women than men, it is clinically important to realise that men were not spared from impaired functional status associated with joint-specific hand symptoms. Moreover, although little data exist on racial/ethnic differences in hand OA, neither were African Americans spared from impaired functional status in association with these hand symptoms. In addition, the associations between hand symptoms and function were just as strong in those with isolated hand symptoms as in those with hand symptoms and concomitant hip or knee symptoms. In one instance, the impact of number of hand joints with symptoms upon HAQ score was actually stronger in those without hip symptoms. The meaning of this counterintuitive interaction is unclear, and we suspect this interaction is unlikely to be clinically relevant.

The serial HAQ scores models we examined showed that the majority of the confounding of associations between joint-specific hand symptoms and total HAQ scores was related, as expected, to concomitant hip and knee symptoms and hip and knee radiographic OA. Although depressive symptoms were strongly associated with worse function, once hip and knee factors were accounted for, depressive symptoms did not significantly further explain the associations between hand joint variables and function.

One potential limitation of our study is the lack of radiographic characterisation of hand OA to allow correlation with joint-specific hand symptoms. This limits some comparisons with previous studies using radiographic definitions of disease. A modest association between radiographic hand OA and hand pain was demonstrated in the Rotterdam study, although this same study found that only radiographic MCP and CMC OA were associated with hand disability.¹⁸ Other studies have shown weaker correlations between radiographic hand OA and hand symptoms.^{4, 19} In rheumatoid arthritis (RA), pain has a greater impact than radiographic damage on HAQ scores.²⁰

We cannot be certain that MCP and other symptomatic hand joints were due to OA, rather than RA, calcium pyrophosphate deposition disease or haemochromatosis. We feel that this is unlikely because of the low prevalence of these conditions and our exclusion of participants with inflammatory conditions on hip or knee radiographs. Our variable comprising symptoms in at least 2 of 3 hand joint sites (DIP, PIP or CMC), as done in the BLSA study,¹⁵ captures a joint distribution typical for hand OA.

Importantly, our hand symptom data were joint-specific, and not generic hand pain, lessening the likelihood of misclassification of the aetiology of the hand symptoms. Lastly, an overemphasis on hand radiographs may miss what is clinically important. For example, data from the Framingham study have shown that of hand joints with clinical symptoms, 40% of men and 58% of women had accompanying radiographic OA. In contrast, of joints with radiographic hand OA, only 8% of men and 17% of women had clinical symptoms.²¹

Since hip x rays were only obtained on women 50 years of age or older, our results cannot be generalised to younger women. Finally, this analysis does not include information on symptoms or radiographic evidence of spine OA, commonly seen in association with hand OA,²² which could potentially contribute to the reporting of difficulty with, or performance of, lower-extremity tasks.²³

This study has significant strengths including its biracial composition of men and women, its population-based design, the inclusion of knee and hip radiography in a single study and its joint-specific hand symptoms definitions. Although the results strictly apply only to the 6 townships from which the sample was drawn, the characteristics of the sample, regarding age and BMI, are reflective of the increasing age and obesity status of the United States in general, making it likely that these associations may be applicable to a wider population.

In summary, individuals with symptomatic hand joints are likely to have functional limitations that go beyond tasks involving the upper extremities alone. Our results suggest that arthritis studies using either self-reported or performance-based functional measures need to consider the impact of symptomatic joints in sites other than the joint site of interest, even if the measures being utilised appear to be specific for the joint site under study.

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