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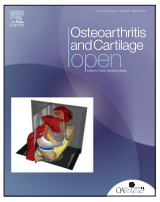

Frequency of multisite non-hand joint involvement in patients with thumb-base osteoarthritis, and associations with functional and patient-reported outcomes

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ABSTRACT

Purpose: In OA studies, the focus often is on an index-joint; other affected joint sites are often overlooked. In this thumb-base OA study, we documented the frequency of symptomatic non-hand joint sites and investigated whether their count was associated with thumb-specific functional and patient-reported outcome measures.
Design: Patients seeking care for thumb-base OA (conservative or surgical) were included. A patient-completed questionnaire captured sociodemographic and health characteristics, symptomatic hand and non-hand joint sites, and outcome measures (thumb-base pain intensity, symptoms and disability (TASD) and upper-extremity disability/symptoms (quickDASH)). Grip and pinch strength were measured. Linear regressions examined the association between each outcome and symptomatic joint site count, adjusted for several covariates.
Results: The mean age of the 145 patients was 62 years, 72% were female. Mean symptomatic non-hand joint site count was 3.6. Ten percent reported only their hands as symptomatic; 30% reported 2–3 other symptomatic sites, and 49% reported 4+. From cross-sectional multivariable analyses, a higher symptomatic non-hand joint site count was associated with worse scores for all patient-reported outcomes and grip strength. Every unit increase in joint site count (49% had a 4+ count) was associated with a 2.1–3.3 unit increase (worse) in patient-reported outcome scores (all $p < 0.02$).
Conclusions: In this sample, nearly 80% of patients had 2+ symptomatic non-hand joint sites. These symptoms were associated with worse thumb- and hand-specific outcomes, suggesting a need for awareness of whole body OA burden, with implications for outcome score interpretations, study designs, and provision of care in thumb-base OA.

1. Introduction

Osteoarthritis (OA) is among the leading contributors to pain and disability globally [1,2]. OA is often clinically approached as a single-joint disease and the vast majority of OA research has focused on individual joints, particularly the knees and hips, but also the hands [1,3]. Hand OA is a common condition [4]. Individuals living with hand OA often can experience pain, joint stiffness, reduced range of motion and grip strength, impaired function, and difficulty undertaking activities of daily living [5,6]; overall health-related quality of life is impacted as a result.

Hand OA typically affects the distal interphalangeal (DIP) joints, proximal interphalangeal (PIP) joints, and the first carpometacarpal (CMC-1) joints [7,8]. Thumb-base OA is defined as OA in the CMC-1 joint; the scaphotrapezoid joint may or may not be involved [9]. Among individuals with symptomatic hand OA, pain and disability are more common with OA in the CMC-1 joint than in the DIP or PIP joints [10]. No disease modifying drugs are currently available for OA, and treatment aims to reduce pain and functional disability. Current pharmacological treatment for hand OA most often is confined to symptomatic treatment, and surgical treatment usually is limited to cases of severe

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OA in the CMC-1 joint. Recommended non-pharmacological modalities include education, hand therapy and splinting [11–13].

A number of core domains have been suggested for use in studies of hand OA, including pain, function, hand strength, and health-related quality of life [14]. Since symptomatic finger joint involvement can be concurrent with thumb-base OA [10,15,16], such symptoms can impact hand outcome measures generally [10,16,17], with implications for determining thumb-base specific treatment effects (non--pharmacological, pharmacological, or surgical) in research studies or in clinical settings. In addition, when the focus is on thumb OA, outcome measures in some cases may not be thumb-base specific.

An additional consideration is the symptomatic involvement of other joint sites, beyond the hands. Hand OA is frequently accompanied by OA in other joint sites, such as the knees or hips. OA studies have reported that individuals that have one joint site affected by OA more than likely will have multiple joint sites affected [18–20]. Furthermore, the greater the number of symptomatic joint sites involved, the greater the risk of negative emotions, disability, and reduced health-related quality of life, all factors that can influence general or joint-specific outcomes in OA [19, 21–24].

In this clinical study of thumb-base OA, we documented the frequency of symptomatic non-hand joint sites. Furthermore, we investigated whether the extent of these symptomatic joint sites was related to sociodemographic and health characteristics, and whether their presence was associated with thumb-specific patient-reported outcome measures and functional measures. Based on literature findings from non-hand clinical OA studies, we hypothesized that a significant proportion of our thumb-base OA patients would report multiple non-hand symptomatic joints, and that the greater the number of symptomatic joint sites, the worse would be thumb-specific patient-reported and functional outcomes measure scores.

2. Methods

2.1. Sample

Symptomatic thumb-base OA (trapeziometacarpal OA) patients scheduled to receive non-surgical management (education, splinting, physiotherapy) or surgical intervention (trapeziectomy with/without ligament reconstruction and tendon interposition) were consecutively recruited from University Health Network, an academic health centre in Toronto, Canada. Patients were excluded from the study if they had corticosteroid injections within the three month period prior to completing the study questionnaire, or had crystalline or post-traumatic arthritis. Patients with any inflammatory types of arthritis were also excluded. Patients provided informed consent to participate, and the study received research ethics board approval (UHN REB #17–5360).

At their initial clinic visit, patients completed a health questionnaire that captured several sociodemographic characteristics, health-related characteristics, and a number of outcome measures. For the 29.0% of patients receiving care for OA in both hands, patients were asked to complete the questionnaire according to the hand for which they experienced more severe symptoms. Functional tests were also administered.

2.2. Study outcome measures

Functional measures, key pinch strength and grip strength, were conducted in triplicate using a dedicated Jamar pinch-gauge and dynamometer (Sammons Preston). Average values were calculated for each and recorded as pinch and grip strength values in kilograms (kg).

Participants were asked to indicate the overall intensity of their thumb pain from 0 to 100 using a Visual Analogue Scale (pain VAS), as well as their symptoms and function using the Trapeziometacarpal Arthrosis Symptom and Disability Questionnaire (TASD) and the shortened Disability of the Arm, Shoulder and Hand scale (quickDASH) [25, 26]. The TASD has 12 items assessing both thumb-specific symptoms and thumb-specific disability. Item responses are indicated on a 5-point scale, and a summative score out of 100 (100 being worst) was obtained by summing the response values, dividing by the number of completed items, subtracting 1, and then multiplying that value by 25. A separate TASD-symptoms and TASD-disability score is derived. The quickDASH is an abbreviated version of the DASH questionnaire that includes 11 items and assesses symptoms and function in the upper extremities. Item responses are indicated on a 5-point scale (1-no disability to 5-extreme disability). Scoring for this measure is equivalent to that of the TASD.

2.3. Symptomatic joint sites

The presence of arthritis-affected symptomatic ("pain, stiffness or swelling most days of the month") joints was collected in the questionnaire using a homunculus diagram [18,20,23] (neck, back, and right and left shoulder, elbow, wrist, hand, hip, knee, ankle, foot). For all joints except the neck and back, a symptomatic site was defined as having a symptomatic joint on either one or both sides (e.g. one/both knees counted as one site). A total symptomatic joint site count, ranging from zero to nine (excluding the hands) was derived. As one of the study objectives was to understand the impact of 'other' joint sites on outcomes in this clinical population, for the upper-extremity-specific quickDASH outcome measure, a separate joint site count variable was derived that excluded all upper-extremity joint sites (i.e. shoulder, elbow, wrist, hand). For the hand for which clinical care was being sought, symptomatic thumb interphalangeal (thumb-IP), thumb metacarpophalangeal (thumb-MCP), and finger metacarpophalangeal (MCP), proximal interphalangeal (PIP), and distal interphalangeal (DIP) joints was recorded. A variable was derived for each of any MCP, any PIP, and any DIP, in addition to an overall indication if any finger joints were marked as symptomatic (i.e. MCP, PIP or DIP).

2.4. Additional study variables

Through the questionnaire, individuals also reported their age, sex, and level of education (dichotomized as '≤secondary' and 'post-secondary'). The Pain Catastrophizing Scale, a 13-item self-administered questionnaire, measures whether an individual ruminates about their pain, magnifies their pain, and whether they feel helpless to manage their pain [27]. Total scores range from 0 (no catastrophizing) to 52 (severe catastrophizing). A score ≥30 is considered a clinically relevant level of catastrophizing [27]. Body mass index (BMI) was calculated (kg/m^2) using each participant's measured height and weight. BMI was also categorized as normal (18≤BMI<25), overweight (25≤BMI<30), or obese (BMI≥30). The AAOS Comorbidity scale was used to capture comorbid conditions, with individuals indicating yes/no to a list of health conditions. A comorbidity count was derived from the sum of 'yes' responses. Radiographic severity of thumb-base OA was assessed by a blinded reviewer using the Eaton-Littler classification system (Stages 1, 2, 3 and 4) [28]. Patients with missing radiographic data were not included.

2.5. Statistical analyses

Descriptive statistics were produced for the overall sample and the distribution of symptomatic joint site groups, which was categorized as 0–1, 2–3, and 4+, with approximately one third of cases in each category, was evaluated according to study variable groupings. Mean outcome measure scores were calculated across symptomatic joint site groups and statistically evaluated.

A negative binomial regression was used to examine the cross-sectional association between symptomatic non-hand joint site count (model outcome) and sociodemographic (age, sex, education) and health-related (pain catastrophizing, BMI, co-occurring condition count) factors, patient type (surgical vs. conservative), and hand-related factors (radiographic thumb-base OA severity, and symptomatic hand joints).

This regression allowed the calculation of adjusted rate ratios where the rate is a continuous count of the outcome (i.e. symptomatic joint site count, excluding the hands).

Linear regressions were used to examine the association between each outcome measure (model outcomes: grip strength, pinch strength, pain intensity, TASD symptom score, TASD disability score, quickDASH score) and symptomatic non-hand joint site count, taking into account age, sex, education, pain catastrophizing, BMI, co-occurring condition count, patient type, radiographic thumb-base OA severity, and presence of any symptomatic finger joints. For interpretive ease, a figure displaying model predicted outcome measure scores against symptomatic non-hand joint site count was generated from each of the fully adjusted regression models.

3. Results

Of 176 patients enrolled, 145 (82%) had radiographic data and comprised the analytical sample. No differences in patient characteristics or outcomes were found between the 145 included and 31 excluded patients. Table 1 presents a description of the sample. The mean age was 62 years (range: 41–87), 72% were female, and 33% and 67% were surgical and conservative management patients. The mean BMI of the sample was 26.8 (SD = 5.5) with about 22% having a BMI indicating obesity. A similar proportion reported two or more co-occurring conditions other than OA. A clinically relevant score on pain catastrophizing was reported by 15% of the sample.

According to the Eaton radiographic classification, 29%, 40% and 28% had Stage 2, Stage 3 and Stage 4 thumb-base OA, respectively. For the hand for which care was being sought, 35% and 44% reported thumb-IP and thumb-MCP symptoms, respectively, and 36% reported at least one symptomatic finger joint (DIP, PIP, or MCP).

The mean number of symptomatic joint sites, excluding the hands, was 3.6. The back was the most common site (60%), followed by similar proportions reporting symptomatic wrist, neck, knees, shoulders or hips (41–48%). Symptomatic feet, ankles and elbows were reported by 33%, 28%, and 20%, respectively. Excluding the hands, one-fifth of the sample reported 0–1 symptomatic joint sites, 30% 2–3 symptomatic joint sites, and 49% 4+ symptomatic sites (Table 1). Females were more likely than males to report 4+ symptomatic joint sites, 54% vs. 37% (Table 1). Number of joints sites was not related to age or body mass index. Also reporting a greater number of symptomatic joint sites were those with a greater number of co-occurring conditions, those with higher thumb-base OA radiographic grade, and individuals reporting any symptomatic finger joints. No association was found between symptomatic joint site count and thumb-IP or thumb-MCP symptoms.

Mean outcome measure scores are also presented in Table 1. For the functional measures, sample mean grip strength was 23.4 kg and mean pinch strength was 5.3 kg. Out of a possible score of 0–100 (100 being

Table 1
Sample characteristics overall, and distribution of symptomatic non-hand joint site count by characteristic.

		Overall %	Distribution of symptomatic non-hand joint site count (%)			p-value[a]
			0–1	2–3	4+	
Overall		100	20.7	30.3	49.0	
Patient Characteristics						
Age	40–49	9.0	15.4	46.2	38.5	0.728
	50–59	29.7	25.6	18.6	55.8	
	60–69	42.8	24.2	27.4	48.4	
	70+	18.6	7.4	48.2	44.4	
Sex	Female	71.7	16.4	29.8	53.9	0.028
	Male	28.3	31.7	31.7	36.6	
Education	≤secondary	19.4	32.1	28.6	39.3	0.145
	post-secondary	80.6	18.1	31.0	50.9	
Patient Type	Surgical	33.1	20.8	35.4	43.8	0.503
	Conservative	66.9	20.6	27.8	51.6	
Body Mass Index	Normal	41.0	18.6	33.9	47.5	0.510
	Overweight	37.5	27.8	27.8	44.4	
	Obese	21.5	12.9	29.0	58.1	
Co-occurring conditions	0	47.2	27.9	30.9	41.2	0.008
	1	30.6	18.2	36.4	45.5	
	2+	22.2	9.4	21.9	68.8	
Pain catastrophizing	Non-clinically relevant	84.8	21.1	33.3	45.5	0.114
	Clinically relevant	15.2	18.8	13.6	68.2	
Hand OA						
Eaton radiographic severity	Grade 2	29.0	28.6	38.1	33.3	0.025
	Grade 3	40.0	20.7	25.9	53.5	
	Grade 4	28.3	12.2	29.3	58.5	
Symptomatic joints, hand receiving care	Thumb IP	35.2	19.6	29.4	51.0	0.720
	Thumb MCP	44.1	20.3	26.6	53.1	0.483
	Any DIP	21.4	6.5	22.6	71.0	0.004
	Any PIP	21.4	12.9	12.9	74.2	0.005
	Any finger-MCP	16.6	8.3	20.8	70.8	0.017
	Any finger joint	35.9	9.6	23.1	67.3	<0.001
Outcome measures		Mean (SD) outcome score within group				p-value[b]
Grip strength (kg)		23.4 (11.3)	29.9 (10.5)	24.2 (11.3)	20.2 (10.3)	<0.001
Pinch strength (kg)		5.3 (3.1)	5.9 (2.4)	5.2 (2.5)	5.1 (3.7)	0.216
Thumb pain intensity[c]		59.7 (25.2)	51.6 (30.5)	56.1 (25.0)	65.1 (21.9)	0.028
TASD symptom[c]		48.8 (18.8)	41.0 (20.6)	45.0 (18.0)	54.4 (17.0)	0.003
TASD disability[c]		49.7 (23.0)	39.7 (24.7)	49.0 (22.8)	54.4 (21.1)	0.017
quickDASH[c]		44.5 (18.8)	33.8 (19.4)	40.6 (18.6)	51.4 (16.0)	<0.001
quickDASH (joint count excluding upper limb joints)[c]		44.5 (18.8)	36.8 (19.4)	43.6 (17.2)	53.3 (16.5)	<0.001

IP: interphalangeal; MCP: metacarpophalangeal; DIP: distal interphalangeal; PIP: proximal interphalangeal; TASD: Trapeziometacarpal Arthrosis Symptom and Disability Questionnaire; DASH: Disability of the Arm, Shoulder and Hand.

[a] distribution of joint groups by characteristics (Mantel-Haenszel chi-square or Kruskal-Wallis test, as appropriate).

[b] mean scores across joint groups (ANOVA test).

[c] Possible range 0–100; higher is worse.

worst), mean pain intensity score in the sample was 59.7, TASD-symptom score was 48.8, TASD-disability score was 49.7, and mean quickDASH score was 44.5.

Mean grip strength significantly decreased, from 29.9 to 24.2 to 20.2 kg, in those with 0–1, 2–3 and 4+ symptomatic joint sites, respectively. A similar pattern with pinch strength was not found. For all thumb-specific and upper-extremity-specific patient-reported outcome measures, mean scores were significantly higher (i.e. worse) with increasing number of non-hand symptomatic joint sites (Table 1). For example, the mean thumb-specific TASD-disability score increased from 39.7 to 49.0 to 54.4 in individuals with 0–1, 2–3 and 4+ symptomatic joint sites, respectively.

Results from the multivariable adjusted negative binomial regression, examining factors associated with the number of symptomatic joint sites, are presented in Table 2. Factors associated with a significantly greater number of symptomatic non-hand joint sites included female sex, a clinically relevant level of pain catastrophizing, a greater number of co-occurring conditions, worse radiographic thumb-base OA severity, and the presence of symptomatic DIP joints.

Linear regression results are presented in Table 3 for the functional measures and Table 4 for the patient-reported outcomes. Symptomatic non-hand joint site count was not found to be associated with pinch strength in the adjusted model (Table 3). However, increasing symptomatic non-hand joint site count was associated with lower grip strength in the adjusted model. For every unit increase in symptomatic joint site count, grip strength was reduced by 0.76 kg ($p = 0.029$). Adjusted for radiographic thumb-base OA severity, presence of symptomatic finger joints, and patient sociodemographic and health-related characteristics, increasing symptomatic joint site count (excluding the hands) was independently and significantly associated with worse scores across all the patient-reported outcomes (pain intensity, TASD-symptoms, TASD-disability, and quickDASH). Rate ratios ranged from 2.10 to 3.25 (p-values ranging from 0.019 to <0.001) per unit increase in symptomatic joint site count (Table 4). Not unexpectedly, we found that patients scheduled for surgery had worse outcome measure scores than those scheduled for conservative management, and individuals with clinically relevant levels of pain catastrophizing also had worse outcome scores.

Fig. 1 graphically displays the fully adjusted relationship between symptomatic joint site count and the functional measure values and each of the patient-reported outcome scores.

Table 2
Negative binomial regression (outcome: symptomatic non-hand joint site count).

	Rate Ratio (95% CL)	p-value
Age	0.99 (0.98, 1.01)	0.395
Sex (female vs male)	**1.42** (1.12, 1.82)	0.005
Education (≤secondary vs. post-secondary)	0.89 (0.67, 1.16)	0.385
Patient Type (surgical vs. conservative)	**0.79** (0.64, 0.99)	0.038
Pain catastrophizing (score 30+ vs < 30)	**1.38** (1.07, 1.79)	0.014
Body Mass Index	1.01 (1, 1.03)	0.134
Co-occurring condition count	**1.17** (1.06, 1.28)	0.001
Radiographic severity stage, thumb CMC		
Stage 3 vs. 2	**1.34** (1.04, 1.73)	0.022
Stage 4 vs. 2	**1.56** (1.17, 2.09)	0.002
Joint symptoms on hand receiving care		
Thumb IP joint	0.97 (0.78, 1.21)	0.783
Thumb MCP joint	0.93 (0.74, 1.16)	0.518
DIP joints	**1.33** (1.02, 1.74)	0.034
PIP joints	0.98 (0.72, 1.32)	0.883
MCP joints	1.20 (0.88, 1.64)	0.254

CMC: carpometacarpal; IP: interphalangeal; MCP: metacarpophalangeal; DIP: distal interphalangeal; PIP: proximal interphalangeal.

4. Discussion

The majority of thumb-base OA patients in this sample reported arthritis-affected symptomatic non-hand joint sites, with nearly half reporting four or more affected sites. A greater number of symptomatic joint sites was associated with poorer patient-reported thumb-specific outcome measures and with poorer grip strength, adjusted for patient characteristics, health-related factors, and hand specific joint symptoms. The findings suggest that an exclusive focus on thumb- or hand-specific joint symptoms in hand OA studies, and in clinical care, may limit our ability to fully appreciate the overall impact of OA.

Several studies have documented the high prevalence of multiple affected joints sites in OA. In a population-based sample among individuals with symptomatic OA, 84% reported pain at two or more sites, and 45% at four or more sites, including the hands [18]. In a UK study of individuals 55+ years of age, the median number of symptomatic joints was four, and less than 15% of individuals reporting any joint problems reported only one symptomatic joint [20]. Multiple symptomatic joints have also been documented among surgical patients undergoing total joint replacement or spine surgery for OA [23,24]. In a hand OA study sample from Norway, the median total body painful joint count was 4 [29], and in an Australian thumb-base OA study, 84% reported OA in other joints [30]. In line with findings from across these studies, we also found a high prevalence of multijoint involvement in our sample, with 29% reporting 2–3 affected joint sites other than their hands, and 49% reporting four or more other symptomatic sites. While multiple symptomatic joints in OA clinical and population-based samples appears to be common for the majority, it is surprising how often it is neglected or undocumented in OA research studies.

It has been reported that patients who experience greater psychological distress and tendency to catastrophize pain have worse hand pain and function scores, and these individuals may additionally benefit less from thumb-base OA treatments [31,32]. Our results support these findings. Across all the outcomes considered in our study, patient-reported and functionally measured, higher pain catastrophizing score was significantly associated with worse scores. We additionally found that individuals with clinically relevant pain catastrophizing scores were significantly more likely to have a higher symptomatic joint site count. Among this group with high catastrophizing scores, 68% reported 4+

Table 3
Multivariable linear regression results (outcomes: grip strength and pinch strength).

	Outcome: Grip strength (kg)		Outcome: Pinch strength (kg)	
	Beta (95% CL)	p-value	Beta (95% CL)	p-value
Symptomatic non-hand joint site count	**−0.76** (−1.44, −0.08)	0.029	0.01 (−0.2, 0.22)	0.912
Age	**−0.17** (−0.34, 0)	0.048	−0.04 (−0.09, 0.01)	0.159
Sex (female vs male)	**−15.19** (−18.42, −11.97)	<0.001	**−3.65** (−4.65, −2.64)	<0.001
Education (≤secondary vs. post-secondary)	−2.67 (−6.28, 0.94)	0.147	**−1.58** (−2.71, −0.46)	0.006
Pain catastrophizing (score 30+ vs < 30)	**−4.85** (−8.69, −1.01)	0.013	**−1.22** (−2.41, −0.03)	0.045
Body Mass Index	−0.02 (−0.27, 0.24)	0.909	**0.15** (0.07, 0.23)	<0.001
Co-occurring condition count	0.74 (−0.68, 2.16)	0.306	−0.18 (−0.62, 0.26)	0.433
Patient Type (surgical vs. conservative)	**−3.13** (−6.1, −0.16)	0.039	**−1.00** (−1.93, −0.08)	0.034
Radiographic severity grade, thumb CMC (3/4 vs 2)	**−3.15** (−6.3, 0)	0.049	−0.34 (−1.32, 0.64)	0.500
Symptomatic finger joints on hand receiving care	−1.55 (−4.46, 1.36)	0.297	−0.39 (−1.3, 0.52)	0.401

CMC: carpometacarpal.

Table 4
Multivariable linear regression results (outcomes: pain intensity, TASD symptom, TASD disability, and quickDASH).

	Outcomes[a]			
	Thumb Pain intensity score	TASD symptom score	TASD disability score	quickDASH score[b]
	Beta (95% CL) p-value			
Symptomatic non-hand joint site count	**2.54** (0.67, 4.41) 0.008	**2.46** (1.19, 3.74) <0.001	**2.10** (0.35, 3.86) 0.019	**3.25** (1.49, 5.01) <0.001
Pain catastrophizing (score 30+ vs < 30)	**10.25** (−0.23, 20.72) 0.045	**9.37** (2.14, 16.6) 0.011	**12.16** (2.18, 22.14) 0.017	**14.85** (7.36, 22.35) <0.001
Body Mass Index	−0.30 (−0.99, 0.4) 0.399	0.04 (−0.44, 0.52) 0.857	0.01 (−0.65, 0.67) 0.976	−0.07 (−0.56, 0.43) 0.797
Co-occurring condition count	−0.14 (−3.98, 3.71) 0.945	−1.10 (−3.76, 1.56) 0.417	−2.43 (−6.09, 1.23) 0.194	0.48 (−2.25, 3.21) 0.729
Patient Type (surgical vs. conservative)	**16.33** (8.2, 24.47) <0.001	**15.33** (9.73, 20.94) <0.001	**13.11** (5.38, 20.84) 0.001	**11.27** (5.45, 17.1) <0.001
Radiographic severity grade, thumb CMC (3/4 vs 2)	**8.67** (0.04, 17.31) 0.049	4.37 (−1.56, 10.31) 0.149	4.98 (−3.21, 13.17) 0.234	0.56 (−5.64, 6.77) 0.859
Symptomatic finger joints on hand receiving care	2.76 (−5.19, 10.71) 0.496	2.29 (−3.15, 7.72) 0.410	2.56 (−4.94, 10.05) 0.504	2.00 (−3.61, 7.62) 0.484

CMC: carpometacarpal; TASD: Trapeziometacarpal Arthrosis Symptom and Disability Questionnaire; DASH: Disability of the Arm, Shoulder and Hand.
[a] All models additionally adjusted for age, sex, and education level.
[b] For quickDASH outcome score model, symptomatic joint site count excluded upper extremity joints.

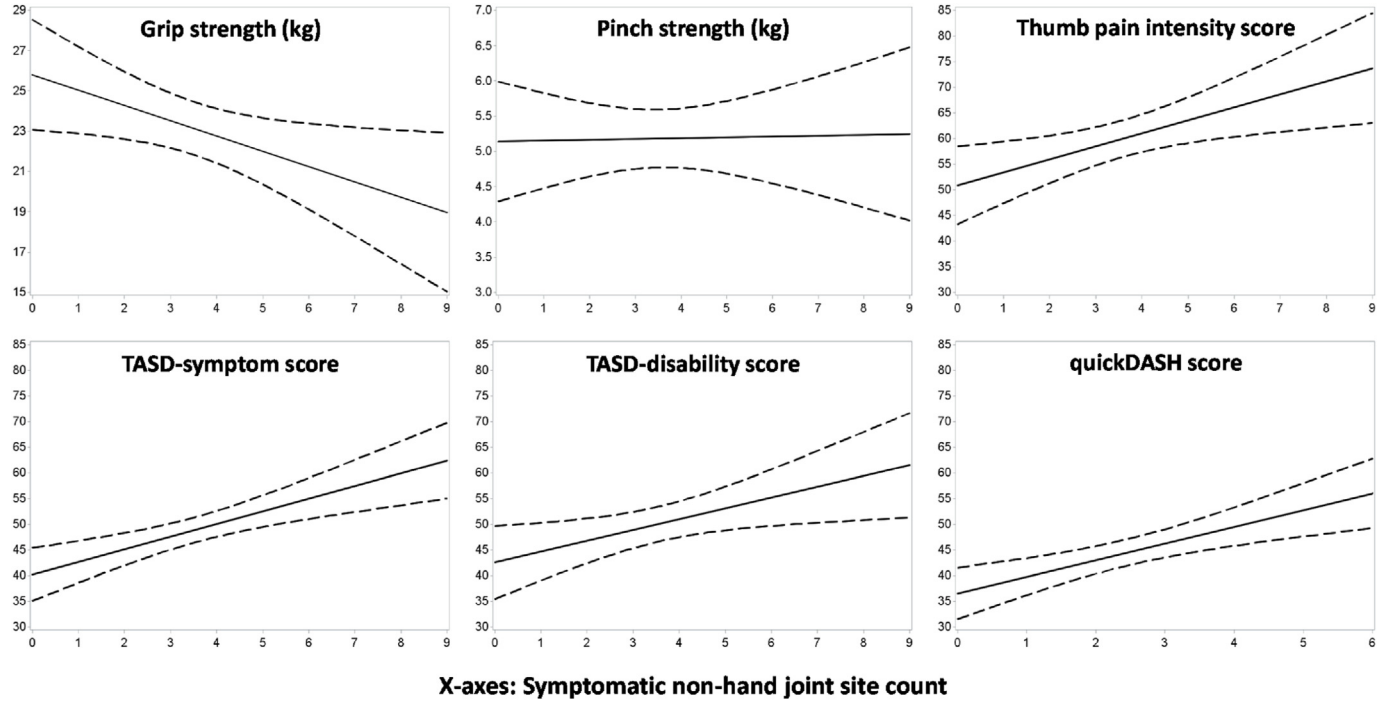

Fig. 1. Predicted outcome scores with increasing symptomatic non-hand joint site count, from fully adjusted models.

symptomatic joint sites, compared to 45% among those without a clinically relevant pain catastrophizing level. From the fully adjusted model, worse pain catastrophizing score was associated with higher symptomatic joint site count.

Previous hand OA studies have presented conflicting results on the associations between BMI and symptomatic hand OA or hand pain [33–35]. We did not find a significant association between BMI and patient-reported thumb pain intensity, nor with thumb-specific symptoms and disability or upper-extremity-specific disability, consistent with some of the cited work. We also did not find an association between BMI and the number of reported symptomatic joints, a perhaps surprising finding given that overweight and obesity are well-established risk factors for OA, though particularly for the knee but also to a lesser extent for the hip and hand. However, in a representative population-based sample examining the association of OA risk factors with number of painful joint sites, Badley et al. similarly found no association between BMI and joint site count, consistent with findings in a clinical population scheduled for primary knee or hip replacement surgery for OA [18]. Hoogeboom et al. also found no difference in mean BMI in patients with hip or knee OA with and without pain in other joints [36]. The role of obesity in multijoint OA clearly requires further exploration.

While we did not find an association between the number of co-occurring conditions and any of the symptomatic and functional outcome measures assessed, we did find a positive association with number of symptomatic joint sites, consistent with findings in other OA studies [18,37]. Multijoint OA may be a phenomenon driven by comorbid inflammation, but systemic low-grade inflammation can also be an important consequence of OA, particularly in the presence of symptoms

including pain, which can exacerbate symptoms and reduce functional performance [38–42]. Although not assessed in this study, it may be that systemic inflammation associated with multiple symptomatic joints in OA may contribute to poorer patient-reported and functionally measured outcomes in hand OA.

We found that higher symptomatic joint site count was associated with worse thumb symptom and disability scores and lower grip strength. For example, for every unit increase in non-hand symptomatic joint site count, thumb-specific pain intensity increased by 2.54 units. Given that nearly half our sample reported four or more symptomatic joint sites, this means that average thumb pain intensity scores for this group, relative to those with no other symptomatic joint sites, are 10 units greater, adjusting for all other factors. A similar impact can be appreciated for the other patient-reported outcomes, with per-unit joint count increases associated with 2.1–3.3 unit increases (worsening) in outcome scores (Table 4). In a similar way, for the nearly half of the sample with 4+ non-hand symptomatic joint sites, average grip strength was 3 kg lower compared to those without other symptomatic joint sites. This suggests that the presence of total body symptomatic joint involvement in hand OA studies, and likely any OA studies focused on an index joint, should not be ignored. Their presence not only has implications for the interpretation of thumb- and hand-specific outcome scores, and potentially for their monitoring over time to assess treatment effectiveness, but likely also for the design of trials for thumb or hand OA interventions and associated patient selection.

Reviews have suggested that central pain sensitization, a phenomenon characterized by increased neural signaling in the central nervous system, contributes to chronic OA pain [43,44]. Continuous nociceptive input from a joint may drive central sensitization in OA, and this can be associated with negative outcomes, including high pain levels, disability and poorer health-related quality-of-life [45–47]. Interestingly, Power et al. reported worse painDETECT scores (a questionnaire-based measure of neuropathic-like pain/symptoms) with a greater number of total body symptomatic joints in a sample of individuals with hip and knee OA [48]. While there is variability in the reported association between neuropathic-like symptoms and sensitization as measured with quantitative sensory testing in OA [49–53], it is possible that the greater the number of symptomatic sites (i.e. the greater and continuous the nociceptive input), the greater the possibility of development of central sensitization over time [49,54,55], with possible consequent effects on measures of pain, and function, in hand OA.

We found worse radiographic severity of thumb-base OA to be associated with worse thumb-base pain intensity scores as well as with reduced grip strength. These findings are consistent with recent work by Haugen et al. in the Nor-Hand study [56]. However, while they also reported an association between grip strength and symptomatic MCP joints on the same hand, we did not find a similar association. As the authors only adjusted for age, sex and BMI in their models, it may be that our inclusion of several additional factors in the regression model may have rendered this association null. In our descriptive analyses, the presence of symptomatic finger DIP, PIP and MCP joints were each associated with a greater number of symptomatic non-hand joint sites; this was also the case when considered globally (i.e. the presence of any of these). However, in the fully adjusted analyses, only the presence of symptomatic DIP joints was significantly associated with a greater number of symptomatic non-hand joint sites. This might explain the discrepancy between the current findings and those reported by Haugen et al.

Hand OA, it is suggested, comprises three phenotypes with possibly distinct risk factors and pathogenesis; thumb-base OA, erosive OA, and nodal or interphalangeal OA [4]. Even so, these phenotypes often can overlap in the same individual [10,15,16]. Deveza et al. reported that individuals with isolated involvement of the CMC-1 joint had less severe impairment in hand function and strength, and these individuals considered themselves less affected overall by their thumb-base OA compared to those with concomitant symptomatic IP joints and radiographic erosions [17]. The authors note that the co-occurrence of symptomatic IP joints and erosive OA may be important factors for consideration in thumb-base OA trials with respect to patient stratification. We concur with Deveza et al., and additionally suggest that total body symptomatic joints, hand and non-hand, require careful consideration in hand OA in our attempts to document and understand its burden, in research and in the clinic.

This study is not without limitations. We did not have data on the severity of OA at other symptomatic finger or other joint sites, nor the constancy or duration of individual joint symptoms to allow for additional discrimination from symptomatic joint count alone. In addition, patients were only asked about symptoms persisting for most days for at least a month. Symptoms can be intermittent and mild for some, and more severe and constant for others. This was not considered, however, and may have resulted in an underestimate of affected joints. While different joints likely contribute to overall multijoint burden to varying degrees depending on the outcome of interest [20], we equally weighted the joint sites in the current study, an approach that does make assumptions but is consistent with work from others [18,19,21,22]. This study was based on a clinical cohort from a single site, which may limit generalizability. However, the current sample shares similar patient and health profiles as has been reported for other thumb-base OA samples cited above. Generalizability may also be limited by the fact that patients were from secondary care and may have more pain and worse disease severity than patients seeking primary care. Even so, patient-reported outcome scores in the current sample showed variability around mean scores which generally resided in the middle of their respective scales, and the sample was nearly evenly divided by thirds with respect to radiographic findings indicating Stage 2, 3, and 4 severity. We did not consider the contralateral hand in the study. Given that a symptomatic joint site was defined as either or both, it would not have made a difference given that by definition hand (thumb) OA was included. However, we did not explore differences, if any, by laterality. Finally, due to our cross-sectional design, causal directionality cannot be suggested.

Thumb-base OA can cause significant symptoms, functional limitations, reduced quality of life, and can impact independence, self-care, and social and leisure activities. Our work supports that symptomatic non-hand joints are not only common in thumb-base OA but also influence thumb- and hand-specific outcomes. The burden of OA, even when the interest may be with a specific joint, cannot be appreciated with an exclusive single joint focus, and our work suggests thumb-base OA is no exception. Our findings may have implications for the design of future hand OA studies, as well as clinical care and the assessment of treatment success. Simply, it appears the presence of other symptomatic joints cannot be ignored. Knowledge of whole body OA burden may be important for self-management approaches, the process of decision-making and evaluation in medical and surgical care, and informing patient expectations.

Author contributions

Conception and design: AVP, EMB, HB.
Analysis and or interpretation of the data: AVP, EMB, DA, JDP, HB.
Drafting of the article: AVP.
Critical revision of the article for important intellectual content: AVP, EMB, DA, JDP, HB.
Final approval of the article: AVP, EMB, DA, JDP, HB.
Provision of study materials or patients: DA, HB.
Administrative, technical, or logistic support: DA.
Collection and assembly of data: HB, DA.

Conflicts of interest

AVP: none.
EMB: none.
DA: none.
JDP: none.
HB: none.

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References

[1] D.J. Kennedy, M. Fredericson, It is the most common form of arthritis and the leading cause of disability in older persons, affecting an estimated 27 million adults in the United States alone. Introduction, Pm r 4 (2012) S1–S2.
[2] K.D. Allen, L.M. Thoma, Y.M. Golightly, Epidemiology of osteoarthritis, Osteoarthritis Cartilage 30 (2022) 184–195.
[3] H.J. Cho, V. Morey, J.Y. Kang, K.W. Kim, T.K. Kim, Prevalence and risk factors of spine, shoulder, hand, hip, and knee osteoarthritis in community-dwelling Koreans older than age 65 years, Clin. Orthop. Relat. Res. 473 (2015) 3307–3314.
[4] M. Kloppenburg, W.Y. Kwok, Hand osteoarthritis–a heterogeneous disorder, Nat. Rev. Rheumatol. 8 (2011) 22–31.
[5] M. Kloppenburg, Hand osteoarthritis–an increasing need for treatment and rehabilitation, Curr. Opin. Rheumatol. 19 (2007) 179–183.
[6] T. Stamm, F. van der Giesen, C. Thorstensson, E. Steen, F. Birrell, B. Bauernfeind, et al., Patient perspective of hand osteoarthritis in relation to concepts covered by instruments measuring functioning: a qualitative European multicentre study, Ann. Rheum. Dis. 68 (2009) 1453–1460.
[7] S. Dahaghin, S.M. Bierma-Zeinstra, A.Z. Ginai, H.A. Pols, J.M. Hazes, B.W. Koes, Prevalence and pattern of radiographic hand osteoarthritis and association with pain and disability (the Rotterdam study), Ann. Rheum. Dis. 64 (2005) 682–687.
[8] Y. Zhang, J. Niu, M. Kelly-Hayes, C.E. Chaisson, P. Aliabadi, D.T. Felson, Prevalence of symptomatic hand osteoarthritis and its impact on functional status among the elderly: the Framingham Study, Am. J. Epidemiol. 156 (2002) 1021–1027.
[9] W. Zhang, M. Doherty, B.F. Leeb, L. Alekseeva, N.K. Arden, J.W. Bijlsma, et al., EULAR evidence-based recommendations for the diagnosis of hand osteoarthritis: report of a task force of ESCISIT, Ann. Rheum. Dis. 68 (2009) 8–17.
[10] J. Bijsterbosch, W. Visser, H.M. Kroon, T. Stamm, I. Meulenbelt, T.W. Huizinga, et al., Thumb base involvement in symptomatic hand osteoarthritis is associated with more pain and functional disability, Ann. Rheum. Dis. 69 (2010) 585–587.
[11] M. Kloppenburg, F.P. Kroon, F.J. Blanco, M. Doherty, K.S. Dziedzic, E. Greibrokk, et al., 2018 update of the EULAR recommendations for the management of hand osteoarthritis, Ann. Rheum. Dis. 78 (2019) 16–24.
[12] Osteoarthritis: care and management. London 2020.
[13] S.L. Kolasinski, T. Neogi, M.C. Hochberg, C. Oatis, G. Guyatt, J. Block, et al., 2019 American college of rheumatology/arthritis foundation guideline for the management of osteoarthritis of the hand, hip, and knee, Arthritis Care Res. 72 (2020) 149–162.
[14] M. Kloppenburg, P. Boyesen, A.W. Visser, I.K. Haugen, M. Boers, A. Boonen, et al., Report from the OMERACT hand osteoarthritis working group: set of core domains and preliminary set of instruments for use in clinical trials and observational studies, J. Rheumatol. 42 (2015) 2190–2197.
[15] M. Marshall, G. Peat, E. Nicholls, D. van der Windt, H. Myers, K. Dziedzic, Subsets of symptomatic hand osteoarthritis in community-dwelling older adults in the United Kingdom: prevalence, inter-relationships, risk factor profiles and clinical characteristics at baseline and 3-years, Osteoarthritis Cartilage 21 (2013) 1674–1684.
[16] M. Marshall, D. van der Windt, E. Nicholls, H. Myers, E. Hay, K. Dziedzic, Radiographic hand osteoarthritis: patterns and associations with hand pain and function in a community-dwelling sample, Osteoarthritis Cartilage 17 (2009) 1440–1447.
[17] L.A. Deveza, S.R. Robbins, V. Duong, A. Wajon, E.A. Riordan, K. Fu, et al., Association of comorbid interphalangeal joint pain and erosive osteoarthritis with worse hand function in individuals with symptomatic thumb base osteoarthritis, Arthritis Care Res. 72 (2020) 685–691.
[18] E.M. Badley, J.M. Wilfong, C. Yip, D.B. Millstone, A.V. Perruccio, The contribution of age and obesity to the number of painful joint sites in individuals reporting osteoarthritis: a population-based study, Rheumatology 59 (2020) 3350–3357.
[19] T.R. Gullo, Y.M. Golightly, R.J. Cleveland, J.B. Renner, L.F. Callahan, J.M. Jordan, et al., Defining multiple joint osteoarthritis, its frequency and impact in a community-based cohort, Semin. Arthritis Rheum. 48 (2019) 950–957.
[20] A.M. Keenan, A. Tennant, J. Fear, P. Emery, P.G. Conaghan, Impact of multiple joint problems on daily living tasks in people in the community over age fifty-five, Arthritis Rheum. 55 (2006) 757–764.
[21] K.A. Butera, S.R. Roff, T.W. Buford, Y. Cruz-Almeida, The impact of multisite pain on functional outcomes in older adults: biopsychosocial considerations, J. Pain Res. 12 (2019) 1115–1125.
[22] A. Finney, K.S. Dziedzic, M. Lewis, E. Healey, Multisite peripheral joint pain: a cross-sectional study of prevalence and impact on general health, quality of life, pain intensity and consultation behaviour, BMC Muscoskel. Disord. 18 (2017) 535.
[23] A.V. Perruccio, J.D. Power, C. Yip, E.M. Badley, M. Canizares, Y.R. Rampersaud, The impact of multijoint symptoms on patient-reported disability following surgery for lumbar spine osteoarthritis, Spine J. 21 (2021) 80–89.
[24] A.V. Perruccio, J.D. Power, H.M. Evans, S.R. Mahomed, R. Gandhi, N.N. Mahomed, et al., Multiple joint involvement in total knee replacement for osteoarthritis: effects on patient-reported outcomes, Arthritis Care Res. 64 (2012) 838–846.
[25] S.J. Becker, T. Teunis, D. Ring, A.M. Vranceanu, The trapeziometacarpal Arthrosis symptoms and disability questionnaire: development and preliminary validation, Hand (N Y) 11 (2016) 197–205.
[26] C. Gummesson, M.M. Ward, I. Atroshi, The shortened disabilities of the arm, shoulder and hand questionnaire (QuickDASH): validity and reliability based on responses within the full-length DASH, BMC Muscoskel. Disord. 7 (2006) 44.
[27] M.J. Sullivan, S.R. Bishop, J. Pivik, The pain catastrophizing scale: development and validation, Psychol. Assess. 7 (1995).
[28] R.G. Eaton, S.Z. Glickel, Trapeziometacarpal osteoarthritis. Staging as a rationale for treatment, Hand Clin. 3 (1987) 455–471.
[29] M. Gloersen, P. Steen Pettersen, T. Neogi, S.R. Jafarzadeh, M. Vistnes, C.S. Thudium, et al., Associations of body mass index with pain and the mediating role of inflammatory biomarkers in people with hand osteoarthritis, Arthritis Rheumatol. 74 (2022) 810–817.
[30] C. Pathmanathan, L.A. Deveza, S.R. Robbins, V. Duong, V. Venkatesha, D.J. Hunter, Determinants of quality of life and hand function among people with hand osteoarthritis, Int J Rheum Dis 25 (2022) 1408–1415.
[31] S. DasDe, A.M. Vranceanu, D.C. Ring, Contribution of kinesophobia and catastrophic thinking to upper-extremity-specific disability, J Bone Joint Surg Am 95 (2013) 76–81.
[32] L. Hoogendam, M.J.W. van der Oest, J. Tsehaie, R.M. Wouters, G.M. Vermeulen, H.P. Slijper, et al., Psychological factors are more strongly associated with pain than radiographic severity in non-invasively treated first carpometacarpal osteoarthritis, Disabil. Rehabil. 43 (2021) 1897–1902.
[33] W. Damman, R. Liu, F.P.B. Kroon, M. Reijnierse, T.W.J. Huizinga, F.R. Rosendaal, et al., Do comorbidities play a role in hand osteoarthritis disease burden? Data from the hand osteoarthritis in secondary care cohort, J. Rheumatol. 44 (2017) 1659–1666.
[34] K. Magnusson, N. Osteras, I.K. Haugen, P. Mowinckel, L. Nordsletten, B. Natvig, et al., No strong relationship between body mass index and clinical hand osteoarthritis: results from a population-based case-control study, Scand. J. Rheumatol. 43 (2014) 409–415.
[35] K. Magnusson, B. Slatkowsky-Christensen, D. van der Heijde, T.K. Kvien, K.B. Hagen, I.K. Haugen, Body mass index and progressive hand osteoarthritis: data from the Oslo hand osteoarthritis cohort, Scand. J. Rheumatol. 44 (2015) 331–336.
[36] T.J. Hoogeboom, A.A. den Broeder, B.A. Swierstra, R.A. de Bie, C.H. van den Ende, Joint-pain comorbidity, health status, and medication use in hip and knee osteoarthritis: a cross-sectional study, Arthritis Care Res. 64 (2012) 54–58.
[37] A.V. Perruccio, C. Yip, J.D. Power, R. Gandhi, N.N. Mahomed, J.R. Davey, et al., Joint involvement in patients with knee and hip OA scheduled for surgery: multi-joint oa, the rule not the exception? Osteoarthritis Cartilage 25 (2017) 191–192.
[38] A.V. Perruccio, V. Chandran, J.D. Power, M. Kapoor, N.N. Mahomed, R. Gandhi, Systemic inflammation and painful joint burden in osteoarthritis: a matter of sex? Osteoarthritis Cartilage 25 (2017) 53–59.
[39] X. Jin, J.R. Beguerie, W. Zhang, L. Blizzard, P. Otahal, G. Jones, et al., Circulating C reactive protein in osteoarthritis: a systematic review and meta-analysis, Ann. Rheum. Dis. 74 (2015) 703–710.
[40] A.V. Perruccio, N.N. Mahomed, V. Chandran, R. Gandhi, Plasma adipokine levels and their association with overall burden of painful joints among individuals with hip and knee osteoarthritis, J. Rheumatol. 41 (2014) 334–337.
[41] B.W. Penninx, H. Abbas, W. Ambrosius, B.J. Nicklas, C. Davis, S.P. Messier, et al., Inflammatory markers and physical function among older adults with knee osteoarthritis, J. Rheumatol. 31 (2004) 2027–2031.
[42] A.J. Hackney, N.J. Klinedinst, B. Resnick, M. Johantgen, Association of systemic inflammation and fatigue in osteoarthritis: 2007-2010 national health and nutrition examination survey, Biol. Res. Nurs. 21 (2019) 532–543.
[43] L. Arendt-Nielsen, Pain sensitisation in osteoarthritis, Clin. Exp. Rheumatol. 35 (Suppl 107) (2017) 68–74.
[44] K. Fu, S.R. Robbins, J.J. McDougall, Osteoarthritis: the genesis of pain, Rheumatology 57 (2018) iv43–iv50.
[45] L. Arendt-Nielsen, H. Nie, M.B. Laursen, B.S. Laursen, P. Madeleine, O.H. Simonsen, et al., Sensitization in patients with painful knee osteoarthritis, Pain 149 (2010) 573–581.
[46] M. Imamura, S.T. Imamura, H.H. Kaziyama, R.A. Targino, W.T. Hsing, L.P. de Souza, et al., Impact of nervous system hyperalgesia on pain, disability, and quality of life in patients with knee osteoarthritis: a controlled analysis, Arthritis Rheum. 59 (2008) 1424–1431.
[47] E. Lluch, R. Torres, J. Nijs, J. Van Oosterwijck, Evidence for central sensitization in patients with osteoarthritis pain: a systematic literature review, Eur. J. Pain 18 (2014) 1367–1375.
[48] J.D. Power, A.V. Perruccio, R. Gandhi, C. Veillette, J.R. Davey, K. Syed, et al., Neuropathic pain in end-stage hip and knee osteoarthritis: differential associations with patient-reported pain at rest and pain on activity, Osteoarthritis Cartilage 26 (2018) 363–369.
[49] R.L. Moore, A.M. Clifford, N. Moloney, C. Doody, K.M. Smart, H. O'Leary, The relationship between clinical and quantitative measures of pain sensitization in knee osteoarthritis, Clin. J. Pain 36 (2020) 336–343.
[50] E.L. Terry, S.Q. Booker, J.S. Cardoso, K.T. Sibille, E.J. Bartley, T.L. Glover, et al., Neuropathic-like pain symptoms in a community-dwelling sample with or at risk for knee osteoarthritis, Pain Med. 21 (2020) 125–137.

[51] J.R. Hochman, A.M. Davis, J. Elkayam, L. Gagliese, G.A. Hawker, Neuropathic pain symptoms on the modified painDETECT correlate with signs of central sensitization in knee osteoarthritis, Osteoarthritis Cartilage 21 (2013) 1236–1242.
[52] A. Soni, V. Wanigasekera, M. Mezue, C. Cooper, M.K. Javaid, A.J. Price, et al., Central sensitization in knee osteoarthritis: relating presurgical brainstem neuroimaging and PainDETECT-based patient stratification to arthroplasty outcome, Arthritis Rheumatol. 71 (2019) 550–560.
[53] S.E. Gwilym, J.R. Keltner, C.E. Warnaby, A.J. Carr, B. Chizh, I. Chessell, et al., Psychophysical and functional imaging evidence supporting the presence of central sensitization in a cohort of osteoarthritis patients, Arthritis Rheum. 61 (2009) 1226–1234.
[54] K. Aoyagi, L.F. Law, L. Carlesso, M. Nevitt, C.E. Lewis, N. Wang, et al., Post-surgical contributors to persistent knee pain following knee replacement: the Multicenter Osteoarthritis Study (MOST), Osteoarthr Cartil Open 5 (2023) 100335.
[55] K.R. Weaver, M.A. Griffioen, N.J. Klinedinst, E. Galik, A.C. Duarte, L. Colloca, et al., Quantitative sensory testing across chronic pain conditions and use in special populations, Front Pain Res (Lausanne) 2 (2021) 779068.
[56] I.K. Haugen, J. Aaserud, T.K. Kvien, Get a grip on factors related to grip strength in persons with hand osteoarthritis: results from an observational cohort study, Arthritis Care Res. 73 (2021) 794–800.