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Full-Length Paper

## The Measure of Activity Performance of the hand (MAP-Hand) – A reliable and valid questionnaire for use in patients with hand osteoarthritis with specific involvement of the thumb



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### ARTICLE INFO

#### Article history:

Received 28 October 2019

Received in revised form

27 October 2020

Accepted 4 November 2020

Available online 12 November 2020

#### Keywords:

Osteoarthritis

Hand

Activity performance

Validity

Reliability

### ABSTRACT

**Study Design:** Cross-sectional methodological study with test-retest design.

**Introduction:** The Measure of Activity Performance of the Hand (MAP-Hand) is an assessment tool measuring hand-related activity limitations.

**Purpose:** To assess reliability, validity, and interpretability of the MAP-Hand in patients with hand osteoarthritis with specific involvement of the thumb (CMC1).

**Methods:** One hundred-and-eighty patients referred to surgical consultation for hand osteoarthritis affecting the CMC1 were included in the evaluation of validity and interpretability. Among these, 59 stable patients were included in reliability analyses, completing the questionnaire twice with a 2-week retest interval. The MAP-Hand has 18 predefined and 5 optional patient-specific items, scored on a 4-point scale (1 = no difficulty to 4 = not able to do). Relative (ICC<sub>2,1</sub>) and absolute (SDC<sub>95%ind</sub>) reliability were calculated. An ICC of >0.70 was considered acceptable. Nine (75%) or more of 12 predetermined hypotheses had to be confirmed for acceptable construct validity. Interpretability was assessed using floor and ceiling effects and considered present if 15% scored at either end of the scale.

**Results:** Mean (SD) age was 63 (8) years, and most patients were women (79%). The mean total score of predefined items showed acceptable reliability (ICC<sub>2,1</sub> 0.74, SDC<sub>95%ind</sub> 0.60) and construct validity. The mean total score of the patient-specific items did not reach acceptable reliability. Ceiling effect was found for the predefined items.

**Discussion and Conclusions:** We found that the mean total score of the predefined items on MAP-Hand had acceptable reliability and construct validity but a ceiling effect in patients with hand osteoarthritis with CMC1 affection.

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Conflict of interest: none.

Submission declaration: This study is not under consideration for publication elsewhere. This article was presented as a poster at Osteoarthritis Research Society International (OARSI) 2018. The abstract was published as a conference abstract in Osteoarthritis and Cartilage, April 2018, 26: S242.

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### Introduction

Hand osteoarthritis (HOA) is a common joint disease,<sup>1</sup> with symptomatic HOA (Kellgren–Lawrence grade (KLG)  $\geq 2$  combined with pain/aching/stiffness) found in 8% of men and 16% of women.<sup>2</sup> Because the prevalence of HOA increases with age,<sup>3</sup> the number of patients with this condition is expected to rise over the next decades as the aging population grows. Clinical signs of HOA are bony

enlargement, soft tissue swelling, bone erosion, and inflammation.<sup>4</sup> Patients may experience pain, stiffness, and reduced grip strength and range of motion,<sup>5</sup> often leading to activity limitations, participation restrictions, and reduced health-related quality of life.<sup>6</sup>

Only limited evidence supports current treatment recommendations for patients with HOA,<sup>1,7</sup> possibly due to lack of high quality randomized controlled trials.<sup>8</sup> Another possible reason for this may be the outcome measures used. Currently, a consensus is lacking regarding the best measure of functional limitations in patients with HOA.<sup>9</sup> Although measurement properties have been presented for different outcomes measuring functional limitations in HOA, the amount of evidence for these properties are varying.<sup>10</sup> The Australian/Canadian Hand OA Index (AUSCAN) and the Functional Index of Hand OA (FIHOA) are among the most frequently evaluated measures in hand OA<sup>10</sup>; but, other questionnaires such as the Patient-rated wrist/hand evaluation (PRWHE),<sup>11,12</sup> the Disability of the Arm, Shoulder and Hand Score (Quick-DASH)<sup>13</sup> and the Thumb disability examination (TDX)<sup>14</sup> also exist. Although the FIHOA, PRWHE, and TDX are shown to measure important patient concepts related to pain and disability,<sup>15</sup> they are together with Quick-DASH mainly based on items selected by clinicians and researchers.<sup>11–14,16</sup> On the other hand, AUSCAN is based on existing questionnaires, opinions of clinicians and patient interviews,<sup>16</sup> however, there are concerns related to the limited access to AUSCAN because of a mandatory fee, and gender- and cross-cultural issues associated with the FIHOA.<sup>9</sup> The OMERACT working group has, therefore, indicated a need for more contemporary self-reported measures of physical function in HOA.<sup>9</sup> Further, emphasis should be placed on assessing measures within different subtypes of HOA.<sup>10</sup>

The Measure of Activity Performance of the Hand (MAP-Hand)<sup>17</sup> is a patient-reported measure of hand activity performance originally developed for persons with rheumatoid arthritis (RA). In contrast to the other measures, the item generation for the MAP-Hand was based solely on patient descriptions of activity limitations.<sup>17</sup> Measurement properties of the MAP-Hand have been assessed both in patients with RA<sup>17</sup> and patients with HOA.<sup>18</sup> Based on the assessment of content validity, the authors concluded that the MAP-Hand reflects activity limitations described by patients with HOA and has adequate internal consistency and responsiveness.<sup>18</sup> However, they recommended further evaluations of reliability and construct validity of the MAP-Hand among patients with HOA.<sup>18</sup> Hence, the aim of the present study was to assess the reliability, validity, and interpretability of the MAP-Hand in patients with HOA with specific involvement of the thumb.

## Method and materials

This methodological study is part of a randomized controlled trial (RCT) (ClinicalTrials.gov: NCT01794754). Data from the baseline assessment of the RCT were used to evaluate construct validity and interpretability. For assessing the test–retest reliability, the patients randomized to the control group filled in the MAP-Hand questionnaire twice, once at baseline and again approximately 2 weeks later. Patients were included for baseline assessment during a 2-year period, from 2013 to 2015.<sup>19</sup> Testing for reliability, construct validity, and interpretability in the current study followed the original COSMIN checklist.<sup>20</sup> The study was approved by the Regional Ethics Committee in Norway (2012/2265/REK sør-øst C).

### Participants

Potential participants were patients referred by their general practitioner to surgical consultation because of thumb base OA (1st carpometacarpal joint, CMC1) at the departments of rheumatology

at St. Olavs Hospital, Haukeland University Hospital, and Haugesund Rheumatism Hospital. Eligible patients were screened by a local project coordinator (occupational therapist [OT]) at each hospital, and persons who did not speak Norwegian, had cognitive dysfunction, or did not have CMC1 OA, were excluded. Previous surgery or pain in other digits was not considered as exclusion criteria. Those giving their written informed consent were included.

### Variables

#### Demographic variables

All patients answered a set of sociodemographic questions, including age, sex, education level, work status, whether they were living alone, hand dominance, and which hand had led to their referral to surgical consultation.

#### Activity performance of the hand

The MAP-Hand contains 18 gender- and season-neutral items of activity performance related to hand function. The items are scored on a 4-point scale from 1 (no difficulty) to 4 (not able to do). A mean total score can be calculated for the 18 predefined items. When the predefined items had missing values, the mean score was calculated based on the number of items with answers, but based on discussions with the developers of the questionnaire, we decided that a minimum of 15 completed items was required.

Additionally, the questionnaire allows patients to describe up to five additional patient-specific items, also scored on a 4-point scale. These items were not part of the original questionnaire but may be useful in the process of setting goals and planning interventions. A separate total mean score may be calculated as the mean of these items. For calculating the mean score for the patient-specific items, only patients who listed and scored at least three activities were included in the analyses.

#### Performance-based and self-reported measures

To assess the construct validity of the MAP-Hand, we developed a priori hypotheses regarding the relationship with scores from other measurement instruments. Function and symptoms of the hand, elbow, and shoulder were measured by the Quick-DASH. This questionnaire consists of 11 questions, with a total score measured on a 0 to 100 scale, with higher scores indicating greater disability.<sup>13</sup> Pinch and grip strength<sup>21,22</sup> were evaluated using Grippit, measured in Newtons, and presented as percentage of normal strength ( $[Measured\ strength / Sex\ and\ age\text{-adjusted\ reference\ values\ from\ Nilsen\ et\ al}^{23}] \times 100$ ). A standard-sized handle was used for both pinch and grip. The patients sat with 90° flexion in their elbow, and the dominant hand was tested first. The patients reported pain on a numeric rating scale (NRS) (0–10, 0 = no pain)<sup>24</sup> following measures of pinch and grip strength. Trained OTs assessed the number of painful finger joints, using a modified version of the Doyle Index<sup>25</sup> to assess painful joints. The OTs scored painful joints by pressure on the lateral joint margin of the CMC1, MCP, PIP, and DIP joints of each hand (0 = no pain, 1 = patient complains of pain; in total 0–15 joints on each hand). Flexion deficit for digits 2 to 5 was assessed with the fingertip-to-palm-distance test,<sup>26</sup> using a goniometer to measure the distance (in millimeters) from the proximal palmar crease to the distal point of each finger. The flexion deficit of all fingers on each hand was summed up to a total flexion deficit score. For determining the width of the grip (opening grip), active palmar abduction of the thumb was measured in degrees using a Pollexograph.<sup>27</sup> The Pollexograph allows the patient to actively move the thumb in a plane perpendicular to the hand. The movement is measured on a box shape with a protractor that is placed exactly on the thenar crease.<sup>27</sup> Health status was assessed by the EuroQol Visual analog

scale (EQ-5D VAS), measuring patient self-reported health on a vertical VAS (0–100, 100 = best health).<sup>28</sup>

### Procedure

At baseline, all patients answered a set of questionnaires, including the MAP-Hand questionnaire, and underwent an examination conducted by an OT at each department before being randomly allocated to intervention or control using a computer-generated list and concealed, opaque enveloped distributed to each of the hospitals. The patients in the control group received a paper version of the MAP-Hand to bring home. After 2 weeks, the OT called them, and they completed the MAP-Hand once more through a telephone interview.

Because reliability should be assessed in stable patients,<sup>29</sup> only those participants who answered that their OA condition was unchanged on a global rating scale of change (5-point scale with answering categories: much worse, little worse, unchanged, little better, much better) at retest were included in the analyses of reliability. For optimizing the validity and reliability of the global rating scale change, the condition was explicitly mentioned in the wording of the question.<sup>30</sup>

### Analyses

The data were analyzed using IBM SPSS statistics 25. Variables are presented as means (SD) or medians (interquartile range, 25th–75th percentile) if continuous and numbers and percentages if categorical. Estimates are shown with 95% confidence intervals (CIs). Missing items of the MAP-Hand are given as numbers and percentages.

### Reliability

A paired *t*-test was used to assess the mean difference (95% CI) between test and retest. The intraclass correlation coefficient (ICC<sub>2,1</sub>) was used to assess relative reliability. An ICC<sub>2,1</sub> of 0.70 was considered acceptable.<sup>31</sup> The standard error of measurement (SEM<sub>agreement</sub>) and the smallest detectable change (SDC<sub>95%</sub>) were used to assess measurement error (absolute reliability). SEM was estimated from a two-way ANOVA ( $SEM_{agreement} = \sqrt{(\sigma_o^2 + \sigma_{po,e}^2)}$ , where  $\sigma_o^2$  is the variance attributable to a systematic error between observations and  $\sigma_{po,e}^2$  is the random error). Based on this, the SDC<sub>95%</sub> was estimated both at individual and group levels using the formulas  $SDC_{95\%ind} = 1.96 \times \sqrt{2} \times SEM_{agreement}$  and  $SDC_{95\%group} = SDC_{95\%ind} / \sqrt{n}$ . Bland–Altman plots were used to visualize limits of agreement between test and retest.

### Construct validity

Construct validity of the 18 predefined items of MAP-Hand was assessed by 12 a priori defined hypotheses. Correlations of <0.30 were graded as low, 0.30 to 0.60 as moderate, and >0.60 as high.<sup>32</sup> In a previous study, results showed that the grip force was reduced in patients with HOA and that grip force and pain during measurement of grip strength accounted for 55% of the variance in functional scores (pain, disability, and joint stiffness of the hand).<sup>5</sup> We, therefore, predicted a moderate correlation between the percentage of normal grip/pinch strength and activity performance (hypotheses 1 and 2), as well as a moderate correlation between pain following grip/pinch force and activity performance (hypotheses 3 and 4). Quick-DASH contains some overlapping questions with MAP-Hand; thus, we hypothesized that the correlation between the two would be moderate to high (Hypothesis 5). HOA is also associated with a reduced range of motion<sup>5</sup>; however, a reduced range of motion may not necessarily indicate worse performance because it can mean more stability for the joints. For this

reason, we assumed that there would be a low correlation between measures of range of motion (palmar abduction and flexion deficit of digits 2–5) and activity performance (hypotheses 6 and 7). Patients with HOA have reported lower health-related quality of life compared to peers.<sup>6</sup> However, we measured only self-reported health, and older persons may have comorbidities affecting their health. Thus, we predicted a low to moderate correlation between self-reported health and activity performance (Hypothesis 8). Men are normally significantly stronger than women,<sup>23,33</sup> indicating that they will have fewer problems with accomplishing daily activities related to grip strength. For this reason, we expected that men would report significantly fewer activity problems than women (hypothesis 9). Symptoms from additional finger joints of the hand have been shown to limit self-reported functional status,<sup>34–36</sup> so we assumed that patients with pain only from the CMC1 joint would report better activity performance than those with pain from additional joints and that the number of joints involved would correlate moderately with activity performance (hypotheses 10 and 11). Because many of the activities of the MAP-Hand represent activities performed with both hands, we also hypothesized that those referred to surgery for both hands would report significantly worse activity performance compared to those referred to surgery for the nondominant hand (hypothesis 12).

For all hypotheses except hypothesis 12, the scores from measures of pain, strength, range of motion, and the number of joints with pain are given as the mean of the right and left hands because many of the items in MAP-Hand are activities performed with both hands.

$P < .05$  was considered to be statistically significant. The MAP-Hand was considered to have acceptable construct validity if nine (75%) or more of the 12 hypotheses were confirmed.

### Interpretability

For the individual predefined items, floor and ceiling effects were considered present if 15% scored “no difficulty” (ceiling effect) or “not able to do” (floor effect).<sup>29</sup>

Additionally, to allow for the possibility of change beyond measurement error, floor and ceiling effects were measured by calculating the proportion of patients scoring within the measurement error at each end of the scale<sup>37</sup> (ceiling effect: scores  $\leq [1 + SDC_{95\%}]$ ; floor effect: scores  $\geq [4 - SDC_{95\%}]$ ). If more than 15% of the patients scored within each of these intervals, the questionnaire was considered to have the floor and/or ceiling effect. Floor and ceiling effects are visualized with the distribution of scores for the mean total score of predefined and patient-specific items.

## Results

The analyses of validity included 180 patients, while the control group used for reliability analyses consisted of 90 patients. However, 34% of patients in the control group reported being a little better ( $n = 5$ ), a little worse ( $n = 23$ ), or worse ( $n = 3$ ) at retest and were therefore excluded from these analyses. Demographic variables did not differ significantly between those included in the reliability analyses ( $n = 59$ ) and the remaining patients included in the total sample ( $n = 121$ ), except for education level, which was higher in patients included in the reliability analyses ( $P = .026$ ). Thus, demographics are presented for the total group (Table 1). The values of the self-reported and performance-based measures are shown in Table 2.

Except for “typing on a computer” ( $n = 10$ ; 6%), there were few missing items on the MAP-Hand questionnaire; “brushing teeth,” “opening cans,” “slicing bread,” “stirring food,” “pushing with

**Table 1**  
Demographic variables of patients with hand osteoarthritis (N = 180)

Demographic variables	Mean (SD)	N (%)
Age, y	63 (8)	
Sex, women		142 (79)
Education		
Primary school		34 (19)
High school		83 (46)
University/college ≤ 4 y		36 (20)
University/college > 4 y		27 (15)
Living alone		35 (19)
Work status		
Full-time work		58 (32)
Part-time work		33 (18)
Student		1 (0)
Retired		60 (33)
Sick leave		32 (18)
Work assessment allowance		7 (4)
Disability pension		32 (18)
Other		4 (2)
Dominant hand, right		168 (93)
Referred hand		
Right		48 (27)
Left		53 (29)
Bilateral		79 (44)

Values are presented as means (standard deviation) or frequencies (percentage).

hands,” and “carrying heavy objects” had one missing item each (1%). Altogether, 16 patients had one missing item each.

Only 47 patients listed three or more patient-specific items and could be included in the reliability testing of the mean total score of the optional patient-specific part of the questionnaire. The majority of the patient-specific answers were defined as “leisure and recreation” according to the International Classification of Function (ICF) structure. The answers were also more gender-related than the predefined items, including activities like knitting, sewing, and using a hammer or a screwdriver.

### Reliability

Relative and absolute reliability values are shown in Table 3. Both predefined and patient-specific mean total scores showed a significant improvement from test to retest ( $P < .001$ ). The predefined mean total score showed acceptable relative reliability ( $ICC_{2,1} 0.74$ ), but the relative reliability for the patient-specific mean total score was not acceptable ( $ICC_{2,1} 0.44$ ). Regarding absolute

**Table 2**

Values of performance-based and self-reported measures for patients with hand osteoarthritis (N = 180)

Functional variables	Mean (SD)
<b>Performance-based measures</b>	
Grip strength (Newtons)	185 (105)
Percentage of normal grip strength	70 (24)
Pinch strength (Newtons)	32 (17)
Percentage of normal pinch strength	66 (24)
Palmar abduction (degrees)	50 (10)
Flexion deficit of digits 2-5 (degrees) <sup>a</sup>	0 (0-5)
<b>Self-reported measures</b>	
Pain following pinch strength (0-10; 0 = no pain)†	3 (2-4)
Pain following grip strength (0-10; 0 = no pain)†	2 (1-4)
Number of painful joints (0-15 joints)	3 (1-6)
Health status (VAS EQ5D, 0-100; 100 = best health)	67 (19)
Disabilities of the shoulder, arm, and hand (Quick-DASH; 0-100; 0 = no disability)	37 (17)
Activity performance (MAP-Hand; 1-4; 1 = no activity problems)	2.0 (0.4)

Variables are presented as means and (SD) if not otherwise indicated.

<sup>a</sup> Median (interquartile range, 25th-75th percentile).

reliability, the mean total score of the predefined items showed a lower measurement error ( $SDC_{95\%} 0.60$ ) than the mean total score of the patient-specific item ( $SDC_{95\%} 0.99$ ). Limits of the agreement are visualized in Figure 1.

### Validity

The results of tests of the a priori hypotheses are presented in Table 4. As predicted, we found a moderate correlation between activity performance measured with MAP-Hand and grip strength ( $r = -0.44$ ), pinch strength ( $r = -0.34$ ), pain following pinch strength ( $\rho = 0.37$ ), and number of painful joints ( $\rho = 0.36$ ), as well as a low correlation with health status ( $r = 0.23$ ) and flexion deficit ( $r = 0.20$ ). With regard to activity performance, we found as predicted that men had a significantly lower score than women (1.7 vs 2.0; mean difference 0.3 [95% CI, 0.2-0.5;  $P < .001$ ]), that those with only CMC1 involvement scored significantly better than those with involvement of additional joints (1.8 vs 2.0; mean difference 0.3 [95% CI, 0.1-0.4;  $P = .001$ ]), and that those referred to consultation for both hands scored significantly worse than those referred for the nondominant hand (1.8 vs 2.0; mean difference 0.2 [95% CI, 0.0-0.3;  $P = .009$ ]). The mean total score of the MAP-Hand was highly correlated with the total score of Quick-DASH ( $r = 0.82$ ). Two of the a priori hypotheses were not confirmed. The correlation between activity performance and pain following grip strength did not reach a moderate level ( $\rho = 0.28$ ), while palmar abduction showed a higher correlation with activity performance than expected and reached a moderate level ( $r = -0.30$ ). With ten of 12 hypotheses confirmed, the mean total score of MAP-Hand showed acceptable construct validity.

### Interpretability

For the individual predefined items, 14 of 18 items showed a ceiling effect, while one item, “opening jam jars,” showed a floor effect (Supplementary Table A). The mean total score of the predefined items showed a small ceiling effect, with 18% scoring within measurement error at the lower end (1 + 0.60 [ $SDC_{95\%}$ ]) of the scale. The optional mean total score of the patient-specific items showed a small floor effect, with 17% scoring within measurement error at the higher end (4-0.99 [ $SDC_{95\%}$ ]) of the scale. Floor and ceiling effects of the mean total scores are visualized in Supplementary Figures A and B.

### Discussion

The main aim of this study was to assess the reliability, validity, and interpretability of the MAP-Hand in patients with HOA. The results show that the mean total score of the predefined MAP-Hand items, but not the optional patient-specific items, has acceptable reliability and construct validity in patients with HOA.

The acceptable reliability shown for the mean total score of the predefined items in MAP-Hand is in accordance with the results of a study assessing MAP-Hand in patients with RA.<sup>17,38</sup> However, in patients with RA, the relative reliability of the MAP-Hand was higher ( $ICC 0.94-0.96^{17,38}$ ) than in the present study ( $ICC 0.74$ ). A possible reason for the lower ICC values in the current study may be differences in the administration of the questionnaire. Although Paulsen et al<sup>17</sup> sent both questionnaires by mail, only the first questionnaire was sent by mail in the present study. Answers to the second questionnaire were given orally by telephone to the OT while the patients had a written copy of the questionnaire in front of them. This method may have induced a difference in score from test to retest. For future studies assessing reliability, the



**Table 3**

Reliability testing of the mean total score of predefined and optional patient-specific items of the Measure of Activity Performance of the Hand (MAP-Hand) in patients with hand osteoarthritis

	n	Test	Retest	Difference	ICC <sub>2,1</sub> (95% CI)	SEM <sub>agreement</sub>	SDC <sub>95%ind</sub>	SDC <sub>95%group</sub>
		Mean (SD)	Mean (SD)	Mean (SD)				
MAP-hand (18 predefined items)	59	1.94 (0.43)	1.80 (0.40)	-0.14 (0.27)	0.74 (0.52, 0.86)	0.22	0.60	0.08
MAP-hand (3-5 patient-specific items)	47	2.83 (0.47)	2.48 (0.47)	-0.35 (0.44)	0.44 (0.05, 0.69)	0.36	0.99	0.14

Test, retest, and mean difference scores are shown with means (standard deviation). Relative reliability is shown with Intraclass correlation coefficients (ICC<sub>2,1</sub>). Absolute reliability is shown with the standard error of measurement (SEM) and smallest detectable change (SDC<sub>95%</sub>) at the individual and group levels.

questionnaire should be administered in the same way if given at multiple measurement points.

In the present report, we have presented the measurement error for predefined items at both the individual and group levels. The smallest detectable change indicates that a change in the mean total score of MAP-Hand above 0.60 at the individual level or 0.08 at the group level is needed to detect a real change beyond measurement error. However, caution should be taken when using this value to detect a real change in samples of different sizes because the calculation of SDC<sub>95%group</sub> is based on the square root of the sample size,<sup>31</sup> implying that a larger sample would have given a lower SDC and vice versa.

With regard to evidence of the construct validity of the MAP-Hand questionnaire, the results from the present study are comparable to those from previous work with patients with RA.<sup>17</sup> In contrast, the MAP-hand questionnaire did not show acceptable construct validity in a previous study in patients with HOA.<sup>18</sup> Fernandes et al<sup>18</sup> found a rather low correlation between the number of affected joints and activity performance, suggesting that the presence of deformities does not necessarily limit activity. Based on these findings, we associated our hypothesis with the number of painful joints instead of the number of joints with structural changes because pain is found to be associated with functional limitation.<sup>34-36</sup> The moderate correlation between the number of painful joints and activity limitation supports that activity limitations may be related more to pain than to structural changes in these patients.

In the present study, we anticipated a low correlation between the range of motion and activity performance. Although the correlation coefficients for flexion deficit of digits 2 to 5 and palmar abduction with activity performance were relatively similar, the findings support only the hypothesis for flexion deficit ( $r = 0.20$ ). The correlation between palmar abduction and activity performance was slightly higher than expected ( $r = -0.30$ ), and thus, considered as moderate. This moderate correlation between limited palmar abduction and reduced activity performance may have clinical implications in that the emphasis should be on preventing adduction contracture for avoiding limited activity performance.

We expected a moderate correlation between activity performance and pain following grip and pinch strength, but this was not confirmed for pain following grip strength ( $\rho = 0.28$ ). Our hypothesis was based on earlier findings that grip strength and pain following grip strength accounted for 55% of the variation in functional performance.<sup>5</sup> However, our study sample reported low pain scores (median NRS score of 2), and this clinical finding may possibly have resulted in a low correlation between pain following grip strength and activity performance. In contrast, pain following grip pinch strength reached a moderate correlation with activity performance. A possible reason for the difference in correlation coefficients between activity performance and pain following grip and pinch strength may be that the patients initially were referred to surgical consultation for their CMC1 OA. Thus, we would expect that activity performance would be more affected by pain following

pinch than grip strength because pain is the main indicator for a referral to surgery.

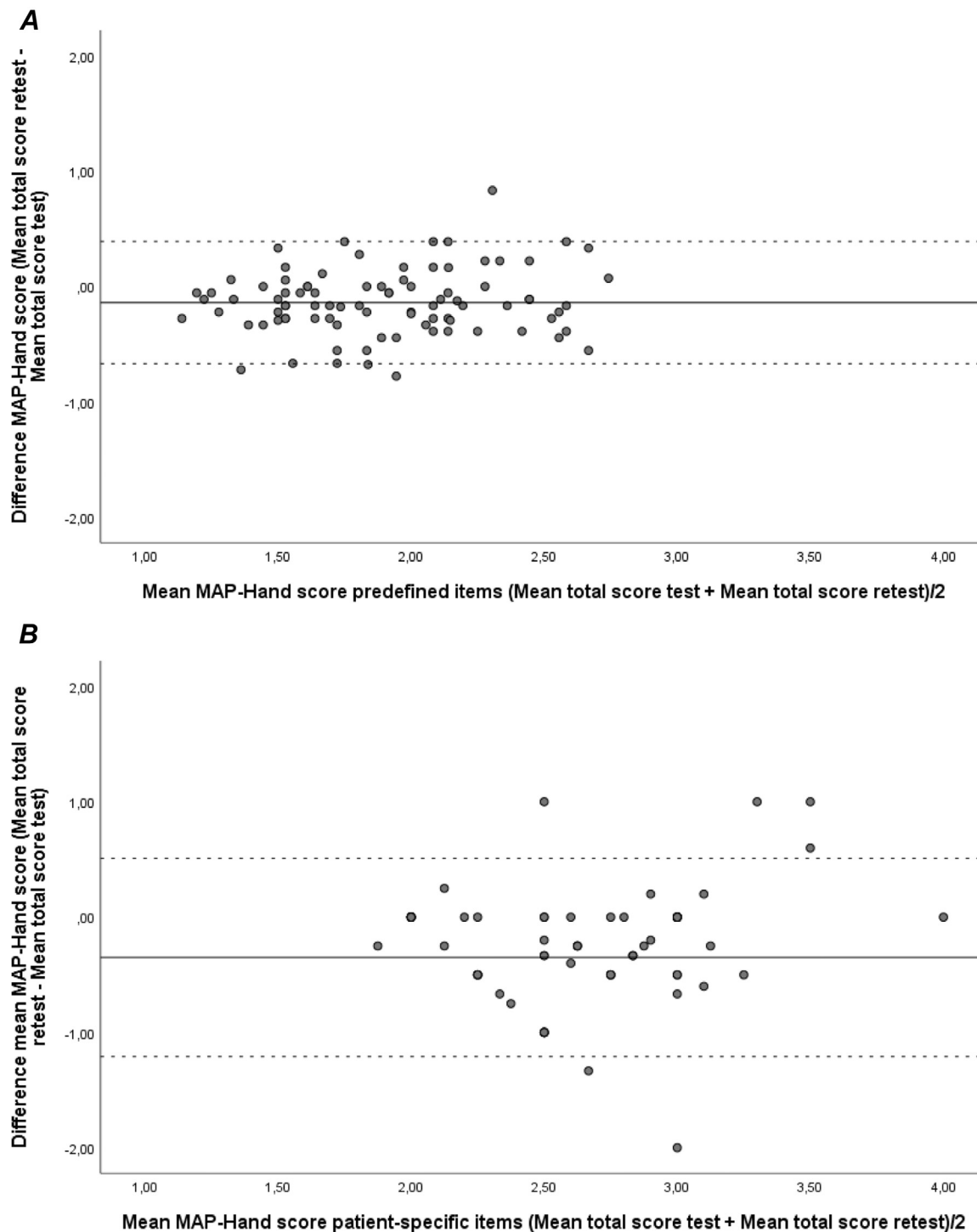
Normal grip patterns can be divided into eight handgrips, as defined by Sollerman et al<sup>39</sup> The MAP-Hand questionnaire was developed to cover these different handgrips, and the authors hypothesized that this possibly would reduce the chance for floor and ceiling effects of the mean total score.<sup>17</sup> Fernandes et al<sup>18</sup> found that 11 of the 18 predefined items showed a ceiling effect (defined as more than 15% reaching the best score, ie, “no difficulty”) in patients with HOA. In the present study, we found that 14 of 18 predefined items showed a ceiling effect; however, with the mean total score used for assessing activity performance, the ceiling effects of the individual items do not provide a complete picture. Calculation of floor and ceiling effects for the mean total score, assessing the percentage of patients scoring within the measurement error (SDC<sub>95%</sub>) at each end of the scale, has not been estimated previously. The current results showed a small ceiling effect for the mean total score of the predefined items, with 18% of the sample not being able to improve beyond measurement error ( $1 + \text{SDC}_{95\%}$ ). These patients had pain scores indicating mild pain (median NRS 3)<sup>40</sup> and a Quick-DASH score that was only slightly lower than the average in the Norwegian population.<sup>41</sup> These results underline that the included patients with HOA had mild to moderate problems related to the hands, and thus, could have exhibited some ceiling effects when scoring the MAP-Hand questionnaire. The interpretability of the MAP-Hand questionnaire should, therefore, be tested in an HOA population exhibiting more severe pain and activity limitations.

The patients had higher scores, indicating poorer activity performance, on the optional patient-specific items compared to the predefined items, showing a small floor effect. This result was expected given that these were all activities perceived as problematic by the patients. Because most of these activities were leisure and recreational and thus possibly not performed daily, their scoring may have been based on recollection more than actual current experience. This distinction may explain why the mean total score of the patient-specific items did not reach acceptable reliability. Because of the patient-specific nature of the questions, these items were not assessed for construct validity. Thus, being an additional, optional part of the questionnaire, the patient-specific items may not be recommended as a stand-alone instrument for measuring activity performance but can be used as an important supplement to the predefined items, providing clinicians with additional activities that are relevant for inclusion in the goal-setting process.<sup>18</sup>

#### Limitations

Only 21% of the present sample were men, possibly threatening the external validity of the results for males with HOA. However, after the age of 50 years, HOA is more common in women than in men,<sup>42</sup> and the sex distribution, therefore, may be representative for patients with HOA seeking treatment for their condition.

When this study was planned, the original version of the COS-MIN Checklist was the recommended checklist;<sup>20</sup> however,



**Fig. 1.** (A) Bland–Altman plot for the total mean score of predefined items of the Measure of Activity Performance of the Hand (MAP-Hand) in patients with hand osteoarthritis ( $n = 59$ ) and (B) for the total mean score of the optional patient-specific items of the MAP-Hand ( $n = 47$ ). The solid line represents the mean difference between test and retest, while the dotted lines represent 95% limits of agreement ( $\text{mean} \pm 1.96 \times \text{standard deviation of the mean difference}$ ).

recently, an updated study design checklist has been published.<sup>43</sup> This has had some implications for the interpretation of the size of the sample. The eligible sample for reliability testing was 90 patients. However, as reliability should be assessed in stable patients,<sup>29</sup> 34% of these patients were excluded from the analyses of the predefined items of MAP-Hand because of self-reported change in their condition. This sample size ( $n = 59$ ) was rated as good

according to the old checklist<sup>20</sup>; however, using the updated study design checklist, the sample size was adequate.<sup>43</sup> The large number of patients reporting change within 14 days may be an indication of symptom fluctuation in patients with HOA. Furthermore, for the patient-specific part of the questionnaire, only those reporting at least three patient-specific activities were included in the analyses, leaving a sample size considered doubtful for this part of the

**Table 4**

A priori formulated hypotheses for the evaluation of the construct validity of the mean total score of the predefined items of Measure of Activity Performance of the Hand (MAP-Hand) in patients with hand osteoarthritis ( $N = 180$ )

	Value	Hypothesis confirmed
1. Moderate correlation between grip strength (% of normal strength) and activity performance of the hand ( $n = 180$ )	$r = -0.44, P < .001$	Yes
2. Moderate correlation between pinch strength (% of normal strength) and activity performance of the hand ( $n = 180$ )	$r = -0.34, P < .001$	Yes
3. Moderate correlation between pain following grip strength and activity performance of the hand ( $n = 180$ )	$\rho = 0.28, P < .001$	No
4. Moderate correlation between pain following pinch strength and activity performance of the hand ( $n = 180$ )	$\rho = 0.37, P < .001$	Yes
5. Moderate to high correlation between function and symptoms of the upper extremity (Quick-DASH) and activity performance of the hand ( $n = 180$ )	$r = 0.82, P < .001$	Yes
6. Low correlation between range of motion of the thumb (palmar abduction) and activity performance of the hand ( $n = 180$ )	$r = -0.30, P < .001$	No
7. Low correlation between flexion deficit (sum of digits 2-5) and activity performance of the hand ( $n = 177$ )	$r = .20, P = .009$	Yes
8. Low to moderate correlation between the health status scale (VAS EQ5D) and activity performance of the hand ( $n = 180$ )	$r = 0.23, P = .002$	Yes
9. Men ( $n = 38$ ) report significantly better activity performance of the hand compared to women ( $n = 142$ )	1.7 (0.4) vs 2.0 (0.4), mean difference 0.3 (95% CI 0.2, 0.5) $P < .001$	Yes
10. Patients with pain only from the CMC joint ( $n = 39$ ) report significantly better activity performance of the hand compared to patients with pain in multiple joints ( $n = 141$ )	1.8 (0.4) vs 2.0 (0.4), mean difference 0.3 (95% CI 0.1, 0.4) $P = .001$	Yes
11. Moderate correlation between number of joints with pain and activity performance of the hand ( $n = 180$ )	$\rho = 0.36, P < .001$	Yes
12. Patients referred to surgery for CMC1 osteoarthritis in both hands ( $n = 79$ ) report significantly worse activity performance than patients referred to surgery for nondominant hand ( $n = 58$ )	1.8 (0.4) vs 2.0 (0.4), mean difference 0.2 (95% CI 0.0, 0.3) $P = .009$	Yes

Hypotheses are analyzed with correlations (presented with Pearson's  $r$  or Spearman's  $\rho$ ) or independent sample  $t$ -tests (presented with means (standard deviation), mean differences (95% confidence interval), and  $P$  values).

questionnaire. The results from the reliability testing should, therefore, be interpreted with caution.

The patients included were initially referred to surgical consultation for CMC1 OA, which may be considered a subtype of OA.<sup>44</sup> In the present study, 78% of patients reported pain from other joints of the hand, supporting that they may be representative of people with HOA in general. However, as all patients had thumb involvement, the results should be confirmed in HOA patients without such involvement.

## Conclusion

The predefined items in the MAP-Hand questionnaire show acceptable reliability and construct validity in patients with CMC1 OA, with a measurement error of 0.6 points. In line with other standardized questionnaires evaluated in this patient group, the MAP-hand questionnaire may be a valid and reliable option for measuring activity limitations in patients with HOA with specific involvement of the thumb. The self-reported items should only be used for identifying additional activity limitations, not for assessing change in activity limitations.

A ceiling effect was found for the predefined items of the MAP-Hand, probably due to a patient sample with only low to moderate pain. Thus, the questionnaire should also be assessed in a sample with more pain and symptoms than the current sample.

## Acknowledgment

We thank the patients who participated in the study. We also thank the South-Eastern Norway Regional Health Authority for funding the project (grant ID 2015109).

## Appendix A. Supplementary Data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jht.2020.11.001>.

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- # 1. The questionnaire contains \_\_\_\_\_ total items
- 20
  - 21
  - 23
  - 25
- # 2. Currently there is \_\_\_\_\_ published evidence supporting traditional treatments for HOA
- limited
  - significant
  - no
  - overwhelming
- # 3. To establish its validity the MAP-Hand was compared to the
- ASHT Guidelines for Treatment of OA Patients
  - Stanford-Yale OA questionnaire
  - Mayo Clinic Hand Function Survey
  - Quick-DASH
- # 4. Reliability of the measure was analyzed using
- a Student T test
  - Cohen's kappa
  - an ICC
  - the Pearson Correlation Coefficient
- # 5. Though the reliability and construct validity were fine, there was a ceiling effect for the patients with involvement of the thumb CMC joint
- false
  - true

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