Objective. This analysis aimed to determine reliability, validity, and responsiveness of the pain on movement (POM) questionnaire, an instrument developed to determine pain intensity induced by head movement.

Design. Data from nine randomized controlled trials for the treatment of chronic nonspecific neck pain were reanalyzed to determine reliability and validity of the POM questionnaire.

Methods. POM was assessed as ratings of pain intensity induced by head movement in six different directions. The instrument’s structure was assessed using a factor analysis. Reliability (internal consistency) was determined using Cronbach’s alpha, and validity (convergent validity) was determined by correlating the POM with pain at rest on a visual analog scale (VAS), the neck disability index (NDI), quality of life (short-form 36 health survey questionnaire [SF-36]), and range of motion. Responsiveness was indicated by sensitivity to changes over time in a subsample of 49 patients.

Results. Overall, 482 patients (mean age 50.3 ± 12.4 years, 72.3% female) were included in the analysis, and 458 of them provided complete data set for the POM. Average POM was 43.9 ± 20.8 mm on the VAS. The POM showed very good reliability as indicated by high internal consistency and moderate validity as indicated by significant correlations with the pain at rest, the NDI, and the SF-36. No correlations were found for POM with range of motion. The POM further proved to be responsive as it was sensitive to changes over time, and those changes were correlated to changes in pain intensity and NDI.

Conclusions. The POM seems to be a reliable and valid instrument to assess POM in patients with chronic nonspecific neck pain.
extension, or rotation. POM might provide a worthy instrument to determine the effects of different interventions on neck pain, such as exercise interventions where patients are confronted with such head movements.

As with all newly developed instruments, measurement properties should be sufficiently investigated before clinical use [20]. Therefore, this analysis of 482 patients allocated in trials for the treatment of chronic nonspecific neck pain aimed to determine reliability, validity, and responsiveness of the POM questionnaire.

**Methods**

**Design**

This analysis used pooled data from nine randomized controlled clinical trials conducted at the Department of Complementary and Integrative Medicine in Essen, Germany between 2008 and 2013 [5,14–19,21,22]. All studies had been approved by the local ethics committee prior to patient recruitment, and all patients had given written informed consent prior to inclusion in the study.

**Patients**

All patients had to have chronic nonspecific neck pain for at least 5 days a week for at least three consecutive months with an average pain intensity at rest of 40–45 mm on a 100-mm VAS in order to be included. The presence of neck pain caused by traumatic, inflammatory, rheumatological, or malignant diseases as well as any serious physical or mental disorder (cancer, polyneuropathy, diabetes mellitus, psychosis, severe depression, etc.) led to exclusion from the trials. Patients were allowed nonsteroidal pain medication and physiotherapeutic interventions, if the treatment regimen had not been altered for 4 weeks prior to the trial and were continued unaltered during the trial; patients also had to document these treatments. On the other hand, patients were excluded if they had invasive treatments such as injections or acupuncture within 4 weeks prior to the trial or surgery within 12 months prior to the trial.

**Assessments**

To measure POM, patients were asked to subsequently flex, extend, laterally flex, and laterally rotate their necks to the left and right as far as possible. The order of movements was consistent for all measurements. To help them with the direction, each movement was illustrated with a picture (Figure 1). The evoked pain during each movement was measured on a 100-mm VAS for each of the six directions and a mean POM score was calculated.

The following measures were used for determination of the convergent validity:

- Current neck pain intensity was measured on a 100-mm VAS [23] with 100 mm being “the worst pain imaginable” before and after the intervention.

- Health-related quality of life was assessed using the short-form 36 health survey questionnaire (SF-36) [25]. This comprehensive 36-item questionnaire yields an eight-scale health profile as well as two component summaries of physical and mental health-related quality of life.

- The cervical range of motion (ROM) was measured in a subsample using an electromagnetic, motion-tracking device (Fastrak, Polhemus, Colchester, VT, USA) [5,26,27]. A small electromagnetic sensor was attached to the forehead using a Velcro strap; patients were then

**Figure 1** Illustration example as part of the questionnaire.

Instruction: Please bend your head forward as far as possible and rate the intensity of your neck pain during this movement.

Patients’ functional neck-related disability was measured using the validated German version [24] of the NDI [13]. This 10-item questionnaire determines how patients see their neck pain affecting their daily activities. The maximum score was 50. Scores of less than 4 indicate no disability; 5–14 indicate mild disability, 15–24 moderate disability, and 25–34 severe disability. Scores above 35 indicate complete perceived disability [13].
advised to move their head as far as possible into a given direction. The ROM was assessed for the same six movement directions as in the POM questionnaire. Movements of the sensor were recorded by the transmitter and converted to Euler angles. Altogether, three trials for each movement direction were performed and averaged.

Finally global improvement was rated using a 5-item Likert scale ranging from "my health is much better" to "my health is much worse."

Statistical Analysis

All statistics were performed using the statistical package IBM SPSS Statistics for Windows (Version 20.0; IBM Corp., Armonk, NY, USA); a probability of <0.05 (two tailed) was considered significant in all tests. In tables and the text, mean values and standard deviation (±SD) are given.

Factor Structure of the POM

An exploratory factor analysis using the principle components extraction and the varimax rotation was performed on the six items of the POM to explore the instrument's structure. Factors were extracted if their eigenvalue was >1. Domain scores of any resulting factors, or of a total score, were calculated as a sum of the component item scores.

Reliability

Cronbach's alpha was calculated to assess the internal consistency of the POM scores.

Validity

The congruence of the POM with other instruments was assessed using Spearman’s correlation coefficients between the POM score and related symptom and domain scores for neck pain patients. The POM score was expected to be significantly correlated with pain at rest (VAS), the NDI, and the subscale bodily pain as well as the physical component summary of the SF-36. For a subsample of 49 patients, the single POM scores were also correlated to their respective flexibility scores (ROM).

Responsiveness

Data from the subsample of 49 patients were also used to determine sensitivity to change. Therefore, patients were classified into two groups comprising those with stable vs those with improved health (global improvement) after 10 weeks of a yoga intervention [5]. Next, the POM change scores between the two groups were compared using an unpaired t-test and the POM change scores were correlated with the change scores of pain at rest (VAS) and the NDI using Spearman’s correlation.

Results

Sample Description

The sample included in this analysis consisted of 482 patients; 129 (26.8%) of them being male and 353 (73.2%) being female. Full data sets were available from 458 patients, indicating a missing 5% of data, mostly due to dropouts before baseline assessment. Another 49 patients also provided ROM data.

The average age was 50.3 ± 12.4 years with a range from 19 to 81 years (see Table 1). Pain intensity was 47.7 mm VAS (±20.3 SD) on average; POM was comparable with average rating of 43.9 ± 20.8 mm VAS. Pain duration ranged from 3 months to 45 years with an average of 7.6 ± 7.5 years. The ROM for each movement direction ranged from 29.6 ± 8.2° (flexion right) to 59.3 ± 11.7° (rotation left).

Table 1 Sociodemographic and clinical characteristics of the analyzed sample (mean ± SD)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sample (N = 458)</th>
<th>Subsample (N = 49)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (F/M)</td>
<td>331/127</td>
<td></td>
</tr>
<tr>
<td>Age (in years)</td>
<td>50.3 ± 12.4</td>
<td></td>
</tr>
<tr>
<td>Average pain intensity (in mm VAS)</td>
<td>47.7 ± 20.3</td>
<td></td>
</tr>
<tr>
<td>POM flexion (in mm VAS)</td>
<td>37.0 ± 24.1</td>
<td></td>
</tr>
<tr>
<td>POM extension (in mm VAS)</td>
<td>46.0 ± 27.1</td>
<td></td>
</tr>
<tr>
<td>POM flexion right (in mm VAS)</td>
<td>44.7 ± 24.9</td>
<td></td>
</tr>
<tr>
<td>POM flexion left (in mm VAS)</td>
<td>47.9 ± 25.7</td>
<td></td>
</tr>
<tr>
<td>POM rotation right (in mm VAS)</td>
<td>42.9 ± 26.1</td>
<td></td>
</tr>
<tr>
<td>POM rotation left (in mm VAS)</td>
<td>44.9 ± 26.7</td>
<td></td>
</tr>
<tr>
<td>Mean POM (in mm VAS)</td>
<td>43.9 ± 20.8</td>
<td></td>
</tr>
<tr>
<td>NDI</td>
<td>29.9 ± 10.8</td>
<td></td>
</tr>
<tr>
<td>SF-36 bodily pain</td>
<td>41.9 ± 14.0</td>
<td></td>
</tr>
<tr>
<td>SF-36 physical component summary</td>
<td>40.4 ± 8.0</td>
<td></td>
</tr>
<tr>
<td>SF-36 mental component summary</td>
<td>46.7 ± 11.3</td>
<td></td>
</tr>
<tr>
<td>ROM flexion</td>
<td>45.7 ± 13.2</td>
<td></td>
</tr>
<tr>
<td>ROM extension</td>
<td>49.5 ± 14.9</td>
<td></td>
</tr>
<tr>
<td>ROM flexion right</td>
<td>29.6 ± 8.2</td>
<td></td>
</tr>
<tr>
<td>ROM flexion left</td>
<td>30.1 ± 7.0</td>
<td></td>
</tr>
<tr>
<td>ROM rotation right</td>
<td>58.9 ± 11.7</td>
<td></td>
</tr>
<tr>
<td>ROM rotation left</td>
<td>59.3 ± 11.7</td>
<td></td>
</tr>
</tbody>
</table>

NDI = neck disability index; POM = pain on movement; ROM = range of motion; SD = standard deviation; SF-36 = short-form 36 health survey questionnaire; VAS = visual analog scale.
one-factor structure explained 65.1% of the variance in the data. The loadings for the six items ranged from 0.71 to 0.86. This supports the use of the POM items as a single scale, scored as the average of the six individual item scores.

Reliability

The internal consistency coefficient obtained was high with Cronbach’s alpha of 0.89, confirming the sufficient homogeneity of the six-item questionnaire. All items contributed equally to the reliability of the scale as all “alpha if item deleted” coefficients were between 0.86 and 0.89.

Validity

Results of the analyses to determine the convergent validity of the POM can be found in Table 2. Correlations were moderate for pain at rest measured by the VAS, and small to moderate for the NDI and the subscale bodily pain as well as the physical component summary of the SF-36. No significant correlations were found for POM and flexibility (ROM).

Responsiveness

Patients reporting improved health reported a decrease of 20.0 mm (±19.3) on the POM compared with the patients with no improvement (−4.2 ± 12.7) (P = 0.005). The difference in POM correlated positively with difference in pain at rest (VAS) (p = −0.47, P = 0.001) and the NDI (p = −0.41, P = 0.004) with moderate size.

Discussion

Summary of the Results

The analysis of the POM showed satisfactory psychometric properties with high internal consistency and moderate convergent validity by significant correlations with the pain at rest intensity (VAS), the NDI, and the SF-36. No correlations were found for POM with ROM. The POM showed further sensitivity to change and those changes were correlated to changes in pain intensity (VAS) and NDI.

Interpretation

Several studies have evaluated the influence on POM during the past years [5,14–19], but only little is known about the relationship between POM and other neck pain indices. This present study found that POM correlated moderately with pain at rest (VAS). Because there was only one other study—a small study [28] that had found a similar correlation—the results could not be compared with others. Although both instruments—pain at rest and POM—apply a VAS and both instruments assess neck pain intensity, they seem to measure different constructs to some extent. In order to determine what other factors influence POM, further studies are required.

This study also found a significant moderate correlation between POM and NDI. Preliminary findings on such relations were rather inconsistent, while in some studies no significant correlations have been found [29]; others reported moderate correlations [30]. The same is true for the correlation of neck pain and quality of life [29,30].

As expected, physical scales of SF-36 were negatively correlated with POM, i.e., those with neck pain reported less health-related quality of life in the physical domains, and no correlation has been found for mental component. Comparable findings have been reported by a study investigating a large Canadian sample [31]; however, this study did not assess POM but rather pain at rest.

Interestingly, no correlations have been found for POM and ROM; this indicates that POM is not just another measure of flexibility or impaired ROM. This is in contrast to other studies [29], where correlations have been found for pain and function [32]. On the one hand, our results could be a consequence of a rather small sample size. On the other hand, other factors might have influenced either POM or ROM; those include, but are not limited to, psychological factors such as fear avoidance or changes in motor function, for example, altered postural or movement patterns due to pain. It must also be mentioned that most patients in that sample had little to moderate neck pain or disability, and the results can therefore not be generalized for all neck pain patients.

Table 2  Convergent validity: correlations between average POM and pain at rest, NDI and subscales, or component summaries of the SF-36, respectively

<table>
<thead>
<tr>
<th>Variable</th>
<th>Correlation Coefficient (Spearman’s ρ)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain at rest VAS (N = 458)</td>
<td>0.47</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>NDI (N = 441)</td>
<td>0.38</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>SF-36 bodily pain (N = 456)</td>
<td>−0.39</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>SF-36 physical component summary (N = 450)</td>
<td>−0.32</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>SF-36 mental component summary (N = 450)</td>
<td>−0.02</td>
<td>0.63</td>
</tr>
<tr>
<td>ROM flexion (N = 49)</td>
<td>−0.10</td>
<td>0.52</td>
</tr>
<tr>
<td>ROM extension (N = 49)</td>
<td>−0.23</td>
<td>0.12</td>
</tr>
<tr>
<td>ROM flexion right (N = 49)</td>
<td>0.11</td>
<td>0.45</td>
</tr>
<tr>
<td>ROM flexion left (N = 49)</td>
<td>−0.15</td>
<td>0.32</td>
</tr>
<tr>
<td>ROM rotation right (N = 49)</td>
<td>0.03</td>
<td>0.86</td>
</tr>
<tr>
<td>ROM rotation left (N = 49)</td>
<td>−0.35</td>
<td>0.14</td>
</tr>
</tbody>
</table>

For ROM, only correlations between pain and range of motion in the same movement direction were assessed. NDI = neck disability index; POM = pain on movement; ROM = range of motion; SF-36 = short form 36 health survey questionnaire; VAS = visual analog scale.
Responsiveness of the instrument was good with significant differences in POM in responders compared with nonresponders, indicating good sensitivity to change. Change scores also correlated well with other instruments’ change scores. Differences observed in the subsample did reach clinical significance; however, minimal clinical important differences have not yet been established for POM.

**Limitation**

This analysis is limited by several factors related to the context of the studies and the patient sample. The validation sample was merged from different clinical trials not specifically designed for validation purposes. The sample was comprised of three times as many females as males and for several analyses, only a small subsample was available.

Results may further be limited by the fact that nonspecific neck pain might not constitute a homogeneous patient sample per se; even after exclusion of traumatic, inflammatory, and secondary causes, there might still be substantial differences between subgroups of patients suffering from chronic neck pain [33]. This might explain differences between studies and different patient samples’ responses.

And finally, there is controversy about the scale of measurement of VAS. While some research shows that the VAS is a ratio scale with interval properties and can therefore be analyzed using parametric statistics [34–36], others argue that it has equivalent format like the numeric rating scale and must therefore be treated as an ordinal scale [37].

**Strengths**

Despite its limitations, this study comprises a large sample to evaluate the reliability and validity of a measure for POM. Because all trials had been conducted at the same department, the questionnaires to determine pain intensity were applied in the same manner.

**Conclusions**

In conclusion, the POM seems to be a reliable, valid, and responsive instrument to assess POM in patients with chronic nonspecific neck pain. Future studies assessing neck pain induced by movement should consider using this validated instrument to ensure comparability between studies and study results.

**Authors’ Contributions**

RL was responsible for conception and design, data collecting, statistical analysis and interpretation of the data, and drafting the manuscript. HC participated in conception and design, data collecting, statistical analysis and interpretation of the data, and critically revised the manuscript. AM participated in data collecting and critically revised the manuscript. JL and GJD participated in the conception of the study and critically revised the manuscript. All authors read and approved the final manuscript.

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