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**Comparing the visual analogue scale (VAS) and the numerical rating scale (NRS) in patient reported outcomes in psoriatic arthritis**

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**Key Indexing Terms:** psoriatic arthritis, visual analogue scale, numerical rating scale, patient-reported outcomes, self-assessment

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**Running head:** VAS vs NRS

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**Abstract**

**Objective**

Patient self-report scales are invaluable in psoriatic arthritis (PsA), as they allow physicians to rapidly assess patient perspectives of disease activity. We aimed to assess the agreement of the visual analogue scale (VAS), a 100 mm horizontal line, and the numerical rating scale (NRS), a 21-point scale ranging from 0 to 10 in increments of 0.5, in patients with PsA.

**Methods**

Data were collected prospectively across three UK hospital trusts from 2018-2019. All patients completed the VAS and NRS for pain, arthritis, skin psoriasis, and global disease activity. A subset completed an identical pack one week later. Demographic and clinical data were also collected.

Agreement was assessed using medians and the Bland-Altman method. Intraclass correlation coefficients (ICC) were used to assess test-retest reliability. Spearman's rank correlation coefficients were used to assess dependency between scale scores and clinical parameters.

**Results**

210 patients completed the study; one withdrew consent, thus 209 were analysed. For pain, arthritis, skin psoriasis and global disease activity, the difference between the VAS and NRS mostly lay within 1.96 SD of the mean, suggesting reasonable agreement between the two scales. 64.1% patients preferred the NRS. The ICCs demonstrate excellent test-retest reliability for both VAS and NRS. Higher VAS and NRS scores were associated with increased tender/swollen joint count, poorer functional status and greater life impact.

**Conclusion**

The VAS and NRS show reasonable agreement in key patient reported outcomes in PsA. Results from both scales are correlated with disease severity and life impact.

Abstract word count: 245 (limit 250)

## Introduction

Psoriatic arthritis (PsA) is a chronic inflammatory arthritis with a significant impact on daily function and quality of life [1,2,3]. To evaluate this in clinical practice, patient self-report scales carry immense value. A commonly used validated scale is the visual analogue scale (VAS), which consists of a 100 mm horizontal line that patients mark based on symptom severity [4,5]. This can be susceptible to random errors during completion or measurement, and systematic error, as photocopying can alter line length[6].

The numerical rating scale (NRS) is a 21-point horizontal scale ranging from 0 to 10 in increments of 0.5, with higher numbers indicating greater severity [7,8]. Compared to the VAS, it is simpler to complete, faster to score, and less susceptible to measurement error [9,10].

To date, the NRS has been validated for outcome measures in ankylosing spondylitis [9]. Although the construct validity of an NRS of patient global health assessment has been validated in PsA [11], the NRS and VAS have not yet been directly compared. Our study aimed to assess the agreement and reliability of the VAS and NRS in PsA for all key outcomes measured using the VAS, and to correlate the results with other clinical measurements and patient outcomes.

## Materials and Methods

### Study design

We conducted a questionnaire study comparing the VAS to the NRS for pain, arthritis, skin psoriasis and global disease activity in patients aged ≥ 18 years with definite PsA (according to the ClASsification of Psoriatic Arthritis (CASPAR) criteria [12] or previous diagnosis by a rheumatologist). Patients were recruited from three UK hospital trusts (Oxford University Hospitals, Leeds Teaching Hospitals, and Bradford Teaching Hospitals) from 20/12/2018 to 22/08/2019.

All patients completed both scales in one clinic visit within usual care. The order the scales were presented alternated throughout the questionnaire. Patients were given an identical pack with a pre-paid self-addressed envelope with instruction to return the completed questionnaires one week later. This ceased when returned

questionnaire numbers were sufficient to evaluate test-retest reliability. The one-week timepoint was chosen as it was assumed that most patients' disease activity state will have not changed significantly. This was clarified via an additional question on disease activity at one-week.

Information was collected on patient demographics and treatment according to a standard protocol. Patients self-rated their disease severity as 'unnoticeable', 'very mild', 'mild', 'moderate' or 'severe', and were asked to indicate their preferred scale. The impact of disease was assessed using the PsAID-12 (psoriatic arthritis impact of disease questionnaire) [13], which has a validated, patient acceptable symptom state (PsAID-12 score $\leq 4$) to stratify high-impact and low-impact disease. Functional status was assessed using the Health Assessment Questionnaire Disability Index (HAQDI) [14]. Patients were also examined by the treating rheumatologist for tender and swollen joint count (TJC/SJC), skin psoriasis body surface area (BSA), Leeds enthesitis Index (LDI) and dactylitis count.

Statistical analyses

Median and interquartile range (IQR) for all variables were calculated due to non-parametric distribution of data. Variability between the VAS and NRS were assessed using the Bland-Altman method, which plots the mean of the scale scores against their difference [15]. The limits of agreement are defined as ±1.96 standard deviations (S.D.) of the mean. For reasonable agreement, points should lie within the limits approximately 95% of the time. Intraclass correlation coefficients (ICC, two-way mixed model absolute agreement) were used to assess test-retest reliability, with ICCs>0.75 considered to demonstrate concordance [9,16]. Spearman's rank was used to assess correlation between different variables. All analyses were performed using R (version 3.6.1).

Ethical considerations

This study was approved by the London-Surrey Research Ethics Committee (reference 18/LO/2057). All patients gave written informed consent.

## Results

Patients

210 patients completed the clinic visit; one withdrew consent and thus data from 209 patients were analysed. 60.0% were male, with a mean age of 51.7 years and a median PsA duration of 7.0 years. Separating by PsA subtype, 84.7% had peripheral, 9.1% had axial, 1.4% had enthesitis predominant and 4.3% had ≥ 2 subtypes. 85.5% patients had limited/no skin psoriasis, 9.6% had extensive skin psoriasis (6-20% BSA), and 1.4% had very extensive skin psoriasis (>20% BSA). 17.7% patients were treated with NSAIDs, 54.5% were treated with csDMARDs, 49.3% were treated with biologics, and 21.5% were treated with combination csDMARD plus biologics.

62 of 107 patients given an identical pack to complete at one week returned the questionnaires. 61.2% were male, with a mean age of 57.2 years and a median PsA duration of 10 years. Their clinical and treatment characteristics were broadly representative of the whole cohort. 36 patients responded to the question assessing their current disease activity compared to their clinic visit (stable=26, improvement=3, deterioration=7).

Scale scores and agreement

The median VAS and NRS for all variables are detailed in Table 1. Median NRS scores tend to be slightly higher than VAS scores. The variability appears to be greatest for global disease activity, and least for skin psoriasis (Figure 1). For all four variables, there appears to be reasonable agreement between the two scales.

In clinic, 64.1% patients preferred the NRS over the VAS. At one week, although a greater proportion preferred the NRS, 14 of 62 patients had changed their preference.

Test-retest reliability

Comparing clinic and one-week VAS scores, the ICCs for pain, skin psoriasis, arthritis and global disease activity were 0.91 (95% confidence interval 0.84-0.94), 0.93 (0.87-0.96), 0.85 (0.74-0.91), 0.89 (0.81-0.93), respectively. For NRS, the ICCs for pain, skin psoriasis, arthritis, and global disease activity were 0.93 (0.88-0.96), 0.89 (0.82-0.94), 0.91 (0.84-0.94), 0.91 (0.85-0.95), respectively. This suggests both scales have excellent test-retest reliability. The results were similar in patients who reported no change in disease activity at one-week (n=26, VAS and NRS ICCs for all variables were ≥ 0.92).

Correlation with disease activity and other clinical outcomes

Table 2 details the median VAS and NRS scores in clinic for all variables, separated by patients' self-reported disease activity. Compared to the 'unnoticeable' group, patients in the 'severe' group had higher VAS and NRS scores. They also had increased TJC/SJC and higher PsAID-12 and HAQDI scores, suggestive of greater life impact and poorer functional status.

Using Spearman's rank, we found statistically significant correlations between clinic global disease activity VAS scores and TJC (Spearman's rho 0.55, $p < 0.001$), SJC (0.49, $p<0.001$), tender entheseal points (0.40, $p<0.001$), HAQDI score (0.64, $p<0.001$) and PsAID-12 scores (0.86, $p<0.001$). Similar trends were found between clinic global disease activity NRS scores and TJC (0.52, $p<0.001$), SJC (0.44, $p<0.001$), tender entheseal points (0.43, $p<0.001$), HAQDI score (0.68, $p<0.001$), and PsAID-12 scores (0.90, $p<0.001$). Notably, correlation between VAS and NRS scores with dactylitis count was not statistically significant ($p>0.05$). This may be due to active dactylitis being uncommon in our cohort, with only 10 patients experiencing active dactylitis. There was also no statistically significant correlation between VAS and NRS scores with age or disease duration (all $p>0.05$). Collectively, these results suggest that results from both VAS and NRS may be taken as a crude correlate of disease activity.

**Discussion**

To our knowledge, our study is the first to compare the VAS and NRS in patients with PsA. We demonstrate that both scales show high levels of agreement in patient reported pain, skin psoriasis, arthritis and global disease activity, and that both have excellent test-retest reliability. Overall, patients indicated a preference of the NRS over the VAS.

Our findings are consistent with previous studies. Price et al. [17] demonstrated that the NRS and VAS are correlated in the measurement of pain in patients with orofacial pain. Van Tubergen et al. [9] found that the NRS and VAS of the Bath Ankylosing Spondylitis Disease Activity Index, Bath Ankylosing Spondylitis Functional

Index and Dougados Functional Index showed high levels of agreement in 536 patients with ankylosing spondylitis. They also found that patients preferred the NRS.

As expected, patients' self-reported disease severity matched the severity of VAS and NRS scores. Higher scores and self-reported disease severity were also associated with greater clinical correlates of active inflammation, and correspondingly, poorer daily function and greater life impact. Those in the self-reported 'moderate' and 'severe' disease severity categories had median HAQDI scores of 0.9 and 2.1, with median PsAID-12 scores of 5.1 and 7.9, respectively. These results echo those from a recent Singaporean study [11], which observed that the NRS of a patient global assessment is strongly correlated with physical and mental function, as assessed by the Short Form-36 questionnaire. It can also differentiate between different levels of disease severity, defined using composite scores including the HAQDI, DAS28 and minimal disease activity criteria.

Strengths of our study include recruitment of patients from 3 separate centres and comparing the scales in an unselected group of patients with PsA within routine clinical practice. Limitations include the sample size being too small to enable detailed analyses of more uncommon features, such as active dactylitis, lack of assessment of sensitivity to change and the absence of objective measures of inflammation such as blood results and imaging. Moreover, the one-week interval between questionnaires also meant some patients felt that their disease activity state had changed.

In conclusion, our results suggest that the NRS and VAS are comparable. This is relevant to both clinical and research settings, where scales are routinely utilised to assess patient's perspectives of disease activity and to evaluate treatment effect.

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**Table and figure legends**

- **Table 1. Median VAS and NRS scores in clinic and home one week later.** VAS: visual analogue scale (scored 0-10); NRS: numerical rating scale (scored 0-10)
- **Figure 1. Bland-Altman plots comparing VAS and NRS in clinic and at home one week later.** VAS: visual analogue scale; NRS: numerical rating scale.
- **Table 2. Clinical assessment outcomes according to patients' self-reported disease activity.** VAS: visual analogue scale (scored 0-10); NRS: numerical rating scale (scored 0-10); PsAID-12: psoriatic arthritis impact of disease questionnaire, HAQDI: health assessment questionnaire disability index.