# Concurrent validity of the Single Assessment Numerical Evaluation and hip-specific patient-reported outcome measures

a cross-sectional retrospective database analysis

**E. M. Bergman,[1,2] E. P. Mulligan,[3] R. M. Patel,[1] J. Wells[4,5]**

[1]School of Physical Therapy, Texas Woman's University, Houston, Texas, USA
[2]Performance Science + Rehab, St. Augustine, Florida, USA
[3]Department of Rehabilitation Sciences, Tufts School of Medicine, Phoenix, Arizona, USA
[4]Department of Orthopedic Surgery, Baylor Scott and White Health, McKinney, Texas, USA
[5]UT Southwestern Medical Center Orthopaedic Surgery Clinic, UT Southwestern, Dallas, Texas, USA

### Aims

The Single Assessment Numerical Evalution (SANE) score is a pragmatic alternative to longer patient-reported outcome measures (PROMs). The purpose of this study was to investigate the concurrent validity of the SANE and hip-specific PROMs in a generalized population of patients with hip pain at a single timepoint upon initial visit with an orthopaedic surgeon who is a hip preservation specialist. We hypothesized that SANE would have a strong correlation with the 12-question International Hip Outcome Tool (iHOT)-12, the Hip Outcome Score (HOS), and the Hip disability and Osteoarthritis Outcome Score (HOOS), providing evidence for concurrent validity of the SANE and hip-specific outcome measures in patients with hip pain.

### Methods

This study was a cross-sectional retrospective database analysis at a single timepoint. Data were collected from 2,782 patients at initial evaluation with a hip preservation specialist using the iHOT-12, HOS, HOOS, and SANE. Outcome scores were retrospectively analyzed using Pearson correlation coefficients.

### Results

Mean raw scores were iHOT-12 67.01 (SD 29.52), HOS 58.42 (SD 26.26), HOOS 86.85 (SD 32.94), and SANE 49.60 (SD 27.92). SANE was moderately correlated with the iHOT-12 ($r$ = -0.4; 95% CI -0.35 to -0.44; p < 0.001), HOS ($r$ = 0.57; 95% CI 0.53 to 0.60; p < 0.001), and HOOS ($r$ = -0.55; 95% CI -0.51 to -0.58; p < 0.001). The iHOT-12 and HOOS were recorded as a lower score, indicating better function, which accounts for the negative r values.

### Conclusion

This study was the first to investigate the relationship between the SANE and the iHOT-12, HOS, and HOOS in a population of patients with hip pain at the initial evaluation with an orthopaedic surgeon, and found moderate correlation between SANE and the iHOT-12, HOS, and HOOS. The SANE may be a pragmatic alternative for clinical benchmarking in a general population of patients with hip pain. The construct validity of the SANE should be questioned compared to legacy measures whose content validity has been more rigorously investigated.

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## Take home message
- The Single Assessment Numerical Evaluation may be a pragmatic alternative to traditional patient-reported outcome measures for the purpose of clinical benchmarking in a general population of patients with hip pain.

## Introduction

Patient-reported outcome measures (PROMs) are standard tools used to measure patient perspectives on a health condition; they are used by clinicians to measure the effectiveness of interventions and by healthcare systems to measure value.[1,2] There are over 30 different PROMs used in people with hip pain, utilized interchangeably between operative and nonoperative patients.[3,4] The implementation and use of PROMs has institutional, practical, and theoretical challenges. Selection of the appropriate PROM to meet the needs of all stakeholders, and standardization of these measures across a healthcare system, is one significant obstacle.[5] Many available instruments have insufficient psychometric evidence to support their use across a variety of populations, and institutional implementation requires staff and technology infrastructure to administer and score PROMs, entailing a fiscal burden.[6] Finally, patients may refuse to participate due to time or technology constraints, or fill out the instruments inaccurately due to survey fatigue, particularly when long or multiple measures are used.[2,6-8] In response to the pragmatic challenges that PROMs present, Williams et al[9] introduced the Single Assessment Numerical Evaluation (SANE) score in 2000,[10] which is a single-question, global PROM which measures level of perceived function by asking patients to rate the current status of their injured body region on a continuous scale from 0 to 100, with 100 representing the patient's perception of full function of the injured area.[10,11]

The psychometric properties of the SANE have been investigated primarily by using the correlation between legacy and body region-specific PROMs at the shoulder,[9,12-14] elbow,[15] neck,[16,17] knee,[11,18-22] ankle,[11,23] and low back.[16] Synthesis of the literature in shoulder conditions using 11 studies found SANE to be valid, reliable, and sensitive to change, with a low barrier to implementation for assessment of postoperative improvement.[24] This synthesis strongly recommended the SANE score be used as a primary PROM in individuals with shoulder pain.[24] Synthesis of literature on the SANE and lower limb conditions was completed by Nazari et al,[11] who found the SANE to be a valid tool to measure patient perception of function in adolescent and young adult female athletes with knee injuries, and in the military population with ankle sprains. The SANE has been investigated at the hip in three studies: two in a hip arthroscopy population,[25,26] and one in a population undergoing total hip arthroplasty.[27] Lau et al[26] investigated the correlation between SANE and the modified Harris Hip Score (mHHS)[28] and Hip Outcome Score (HOS).[29] The authors found significant correlations at both the preoperative and postoperative timepoints, with a mean follow-up time of eight months. Correlation strength for the mHHS and the SANE was $r = 0.66$ and $r = 0.54$ (p < 0.001) for the activities of daily living (ADL) and sports subscales, respectively, at the preoperative timepoint and from $r = 0.60$ and $r = 0.65$ (p < 0.001) for the ADL and sports subscales of the HOS, respectively, also at the preoperative timepoint.[26] Dumont et al[25] investigated the correlation of the SANE and hip-specific PROMs in patients undergoing arthroscopic surgery for femoroacetabular impingement at the preoperative timepoint. The authors found moderate correlation between the SANE and the mHHS, the 33-question International Hip Outcome Tool (iHOT)-33,[30] Hip Outcome Score Sports Scale (HOS-SS),[29] and HOS-ADL,[29] respectively ($r = 0.351$, p < 0.001; $r = 0.445$, p < 0.001; $r = 0.386$, p < 0.001; $r = 0.430$, p < 0.001).[25]

In the hip arthroplasty population, Torchia et al[27] investigated the correlation of the SANE with the Hip disability and Osteoarthritis Outcome Score, Joint Replacement (HOOS-JR)[31] and the PROM Information System (PROMIS-10)[32] in 136 patients one year postoperatively. They found a strong correlation between the SANE and the HOOS-JR ($r = 0.75$; p < 0.001) and PROMIS-10 physical component summary ($r = 0.63$; p < 0.001).[27] Each of these studies concluded that SANE is a pragmatic alternative to use of longer, historically validated PROMs in a clinical setting.

The limited body of literature available on the SANE score suggests concurrent validity between it and legacy measures of body region-specific function in musculoskeletal conditions, including symptomatic hip patients. Establishing concurrent validity requires testing the correlation of the reference standard PROM with the SANE at the same timepoint.[33] The current study aims to be the first study to investigate concurrent validity of the SANE with the 12-question iHOT-12,[34] HOS, and HOOS in a population of patients with hip pain at the time of initial consultation with an orthopaedic hip preservation specialist. We hypothesize that this population will demonstrate strong and significant correlation between the SANE and the iHOT-12, HOS, and HOOS.

## Methods

### Sample

This study was approved by the Institutional Ethics Review Board of the University of Texas Southwestern (STU 122016-058) and the Institutional Review Board of Texas Woman's University, Houston campus (IRB-FY2023-98). Data from 2,782 patients at initial evaluation with a hip preservation specialist (JW) were analyzed at the time of initial consultation using the iHOT-12, HOS, HOOS, and SANE between January 2016 and December 2020.

### Assessment instruments

The SANE is a global, single-item PROM administered using the following question: "On a scale from 0 to 100, how would you rate your (e.g. injured limb) today, with 100 being normal?"[9,10] SANE reliability has not been investigated in patients with hip pain; however, in people with shoulder pain, it has been found to have excellent reliability with an interclass correlation coefficient (ICC) > 0.80.[35] A systematic review of SANE in lower limb pathologies found the minimal clinically important difference (MCID) to be 7.0 to 19.0 at six- and 12-month follow-up respectively; however, no conclusions could be made on the reliability of the SANE in lower limb pathologies due to the quality of the limited number of studies.[9,11]

The iHOT-12 is a 12-question survey developed with feedback from patients and adapted from the original 33-question (iHOT-33) survey to assess quality of life in active people with nonarthritic hip pain.[34] It is the recom-

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**Table I.** Baseline patient characteristics (n = 2,782).

| Characteristic | Value |
| --- | --- |
| Mean age, yrs SD | 54.54 (18.9) |
| Female, n (%) | 1,198 (43.1) |
| Male, n (%) | 866 (31.1) |
| Mean height, in (SD) | 66.59 (5.11) |
| Mean weight, lbs (SD) | 174.24 (45.97) |
| Previous hip surgery, n (%) | 504 (18.12) |
| Mean UCLA activity score (SD) | 4.99 (2.48) |

UCLA, University of California, Los Angeles.

**Table II.** Descriptive statistics for each patient-reported outcome measure used in this study.

| Variable | Number | Mean (SD) | Chronbach's α |
| --- | --- | --- | --- |
| SANE | 1,475 | 49.6 (27.92) | |
| iHOT-12 | 1,838 | 60.62 (25.19) | 0.95 |
| HOS | 1,839 | 52.16 (24.30) | 0.98 |
| HOOS | 1,863 | 57.72 (18.14) | 0.98 |

HOOS, Hip disability and Osteoarthritis Outcome Score; HOS, Hip Outcome Score; iHOT-12, International Hip Outcome Tool-Short Form; SANE, Single Assessment Numerical Evaluation.

**Table III.** Pearson correlation coefficients for hip patient-reported outcome measures and Single Assessment Numerical Evaluation.

| Variable | Number | Pearson (r) | 95% CI | p-value* |
| --- | --- | --- | --- | --- |
| iHOT-12 | 1,456 | -.040 | -0.44 to.35 | < 0.001 |
| HOS | 1,455 | .057 | 0.53 to 60 | < 0.001 |
| HOOS | 1,464 | -0.55 | -0.58 to -0.51 | < 0.001 |

*Pearson correlation coefficient.
HOOS, Hip disability and Osteoarthritis Outcome Score; HOS, Hip Outcome Score; iHOT-12, International Hip Outcome Tool-Short Form.

mended tool for patient-reported outcome assessment both for nonarthritic hip pain and for patients undergoing hip arthroscopy.[36] Reliability has been reported to be fair for routine use in clinical practice.[34,37] The test-retest reliability has been reported to be ICC = 0.86 to 0.93, with excellent content validity as a patient-generated questionnaire.[34,37,38] Patients scored each of the 12 items from 0 to 10, with 0 meaning no problem or pain and 10 representing extreme difficulty or pain.

The HOS is a 28-item questionnaire with a sports and ADL subscale.[39] The MCID has been found to be 8.3 for the HOS-ADL subscale and 14.5 for the HOS-SS in patients with femoroacetabular impingement undergoing arthroscopic surgery.[40] The ICC values for the ADL and sports subscales are 0.98 and 0.92, respectively, with a minimal detectable change of 3.[39,41] The MCID for the HOS-ADL is 9 and for the HOS-SS is 6.[39,41] The content validity of the HOS has been questioned due to its lack of patient input during its development.[42]

The HOOS is a 40-item survey intended to measure self-perceived function and symptoms in patients with hip osteoarthritis.[43] The HOOS has assessed five different dimensions: pain, stiffness, limitations in ADL, sports and recreation, and hip-related quality of life.[43] The most recent systematic review of HOOS measurement properties found 11 studies supporting its content validity and reliability in patients undergoing hip arthroplasty.[3]

**Statistical analysis**
Data were imported from a secured web application (REDCap, USA) into IBM SPSS statistical software v. 29.0.2.0 (IBM, USA)

after merging and cleaning. Normality was assessed and met for each PROM for each measure based on the large sample size and observation of skewness and kurtosis. Pearson correlations were calculated between the SANE and condition-specific measures (iHOT-12, HOS, and HOOS). Cases with missing data were eliminated pairwise for analysis. The a priori α level for significance was set at p < 0.01.

**Results**
Baseline demographic data (n = 2,782) are included in Table I. The mean patient age was 55.54 years (SD 18.9); 1,056 patients (38.9%) were male and 1,659 patients (59.6%) were female, and 67 patients (2.4%) did not have sex recorded in the database. A total of 504 (18%) of the sample reported a prior history of surgery. Activity level was measured using the University of California, Los Angeles (UCLA) activity score[44] with a mean score of 5/10, indicating moderate activity levels such as swimming and unlimited housework or shopping. Mean scores scaled as a percentage were iHOT-12 55.8%, HOS 48.7%, HOOS 54.3%, and SANE 49.6% (Table II).

Results of correlation analysis, including the number of valid pairs available for analysis for each comparison, are shown in Table III. The SANE score was moderately correlated with the iHOT-12 (Pearson r = -0.40, 95% CI -0.35 to -0.44; p < 0.001, Pearson correlation coefficient) (Figure 1), HOS (Pearson r = 0.57, 95% CI 0.53 to 0.60; p < 0.001, Pearson correlation coefficient) (Figure 2), and HOOS (Pearson r = -0.55, 95% CI -0.51 to -0.58; p < 0.001, Pearson correlation coefficient) (Figure 3). The iHOT-12 and HOOS were recorded as a lower score, indicating better function (opposite of SANE), which accounts for the negative correlation coefficients.

**Discussion**
This study found that the SANE was moderately and significantly correlated with the iHOT-12, HOS, and HOOS in patients with hip pain at the time of initial evaluation with an orthopaedic surgeon. Concurrent validity of the SANE with PROMs used in people with hip pain has been evaluated in a hip arthroscopy population (mHHS: r = 0.35 to 0.66, HOS subscales: r = 0.39 to 0.65, and iHOT-33: r = 0.45).[25,26] In their study of 154 patients pre-hip arthroscopy, Dumont et al[25] found a moderate correlation between the SANE and the iHOT-33 (r = 0.45; p < 0.001). The current study had a significantly higher number of participants and found a stronger correlation between the iHOT-12 and the SANE (r = 0.58; p < 0.001).[25] Torchia et al[27] evaluated the concurrent validity of the SANE and the HOOS-JR in 136 patients at one year
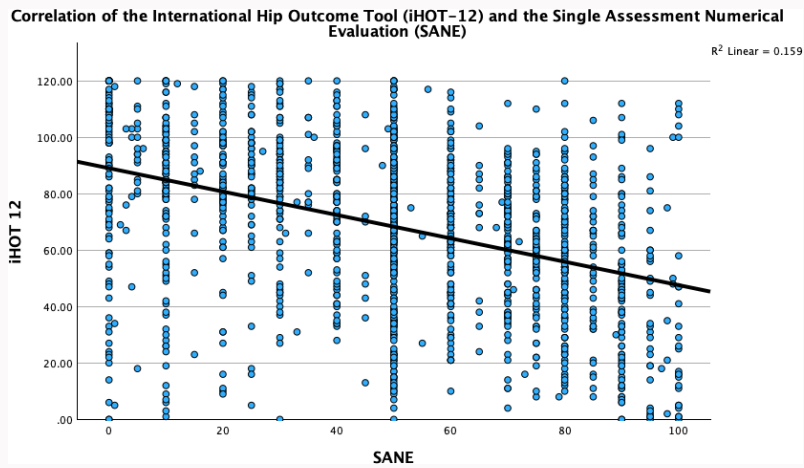
**Fig. 1**

Correlation of the Single Assessment Numerical Evaluation (SANE) and the International Hip Outcome Tool (iHOT-12) at a single timepoint upon initial evaluation with an orthopaedic surgeon who is a hip preservation specialist (JW).
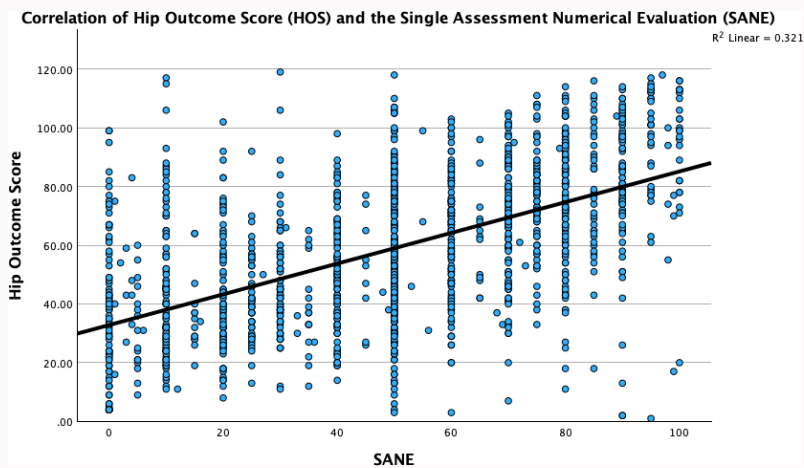


**Fig. 2**

Correlation of the Single Assessment Numerical Evaluation (SANE) and the Hip Outcome Score (HOS) at a single timepoint upon initial evaluation with an orthopaedic surgeon who is a hip preservation specialist (JW).
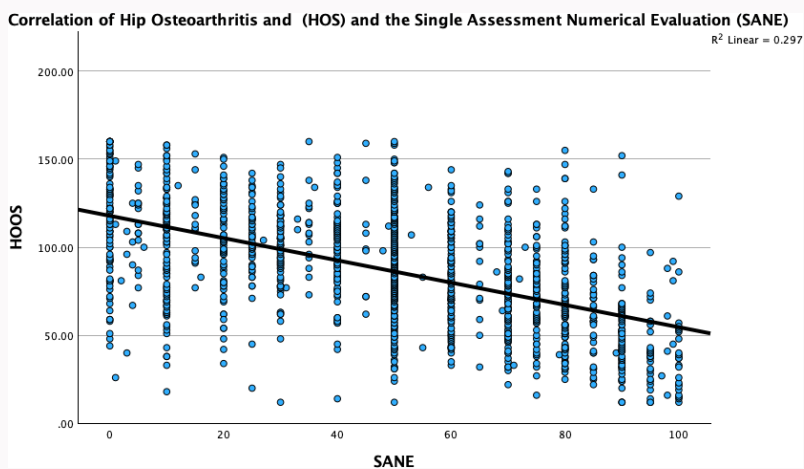


**Fig. 3**

Correlation of the Single Assessment Numerical Evaluation (SANE) and the Hip disability and Osteoarthritis Outcome Score (HOOS) at a single timepoint upon initial evaluation with an orthopaedic surgeon who is a hip preservation specialist (JW).

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post hip arthroplasty and found a higher correlation than the current study (*r* = 0.75; p < 0.001) compared to our observation of *r* = −0.55 (p < 0.001). This study identified two new PROM variations (iHOT-12 and HOOS) that demonstrated moderate correlation with SANE. The study also found moderate correlation of the SANE and the summative HOS score (vs individual subscale scores) in a general population with hip pain at a single timepoint.

Establishing concurrent validity requires testing the relationship of the reference standard PROM with the SANE at the same timepoint. In previous studies, acceptable concurrent validity has been defined as Pearson correlation coefficients > 0.70;[16] however, no absolute cutoff score to establish concurrent validity is universally agreed upon. Although this study showed moderate rather than strong correlation of SANE and iHOT-12, HOS, and HOOS, it adds to a body of evidence supporting the use of SANE as a pragmatic alternative for clinical benchmarking in people with hip pain.

PROMs are a complex proxy for a gold standard in measurement of patient-reported function.[33] PROMs typically have a multidimensional structure such that the combination of a global measure of health and a condition- or body region-specific measure of health are used together to provide the most accurate assessment of the patient's perception of their health and function related to their current medical condition.[5] When comparing a single-item PROM such as the SANE with multidimensional, region-specific PROMs, the construct of function is simplified to one uniform concept. In the context of a clinical encounter, patients and clinicians may prefer the SANE for efficiency and brevity. In addition, use of the SANE allows the patient to define functional ability within their own unique social and historical context, with the tradeoff of the clinician having a limited understanding of what those factors are for an individual patient.[16,45]

This study was one of the largest retrospective analyses of PROMs in people with hip pain that included evaluation of the SANE; however, the study sample was not stratified by diagnosis to match the validated PROM to the diagnostic population for which it was intended. Future research should match hip-specific PROMs by diagnosis to further investigate the concurrent validity of the SANE in people with hip pain. Mixed-methods investigations, including patient interviews, may be useful in understanding the individual constructs that SANE measures and patient preference in format and length of SANE versus traditional PROMs.

This study was the first to investigate the relationship of SANE and iHOT-12, HOS, and HOOS in a population of patients with hip pain at the initial evaluation with an orthopaedic surgeon. We found moderate correlations between the iHOT-12 (*r* = -0.40, 95% CI -0.35 to -0.44; p < 0.001), HOS (*r* = 0.57, 95% CI 0.53 to 0.60; p < 0.001), and HOOS (*r* = -0.55, 95% CI -0.51 to -0.58; p < 0.001). Concurrent validity of the SANE did not meet previously published definitions of strong correlation with the iHOT-12, HOS, or HOOS (*r* ≥ 0.70); however, SANE may have clinical utility for benchmarking progress. Future studies should investigate SANE as an outcome measure at multiple timepoints to investigate its psychometric properties as a postoperative PROM. The underlying construct validity of each scale likely differs significantly due to the unidimensional nature of SANE.

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## Author information

**E. M. Bergman**, PT, DPT, PhD(c), PhD Candidate, Innovation Director,
School of Physical Therapy, Texas Woman's University, Houston, Texas, USA;
Performance Science + Rehab, St. Augustine, Florida, USA.

**E. P. Mulligan**, PT, DPT, Associate Professor, Department of Rehabilitation Sciences, Tufts School of Medicine, Phoenix, Arizona, USA.

**R. M. Patel**, PT, PhD, Associate Professor, School of Physical Therapy, Texas Woman's University, Houston, Texas, USA.

**J. Wells**, MD, MPH, FAAOS, Assistant Professor, Department of Orthopedic Surgery, Baylor Scott and White Health, McKinney, Texas, USA; UT Southwestern Medical Center Orthopaedic Surgery Clinic, UT Southwestern, Dallas, Texas, USA.

## Author contributions

E. M. Bergman: Conceptualization, Methodology, Writing – original draft, Formal analysis, Investigation, Project administration, Writing – review & editing.
E. P. Mulligan: Conceptualization, Writing – review & editing, Formal analysis, Investigation, Methodology.
R. M. Patel: Conceptualization, Visualization, Writing – review & editing, Formal analysis, Investigation, Methodology, Supervision.
J. Wells: Conceptualization, Project administration, Writing – review & editing, Data curation, Supervision, Validation.

## Data sharing

The datasets generated and analyzed in the current study are not publicly available due to data protection regulations. Access to data is limited to the researchers who have obtained permission for data processing. Further inquiries can be made to the corresponding author.

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