ISSN: 2754-4737

Journal of Neurology Research Reviews & Reports

SCIENTIFIC Research and Community

Research Article

Open Access

Assessment of Neurological Deficits Using the Stroke Impact Scale

Sue Min Lai, PhD, MS, MBA

Professor of Epidemiology and Program Director, Kansas Statewide Cancer Registry, University of Kansas Medical Center, Kansas City, Kansas, USA

ABSTRACT

Background and Purpose: This study evaluated physical and social functioning using the Stroke Impact Scale (SIS) and Short Form-36 (SF-36) to assess health-related quality of life in patients following stroke.

Methods: The SIS and SF-36 were administered to 278 stroke patients approximately 90 days after stroke. The SIS-16 and SF-36 Physical Functioning (PF) domain were used to assess physical functioning, while the SIS Participation and SF-36 Social Functioning (SF) domains were used to assess social functioning. Descriptive statistics and analysis of variance (ANOVA) were used to characterize physical and social functioning after stroke across different levels of the modified Rankin Scale (mRS).

Results: Both the SIS-16 and SF-36 PF domains demonstrated substantial floor effects. In contrast to the SIS Participation domain, the SF-36 SF domain showed substantial ceiling effects. Both the SIS-16 and SF-36 PF domains effectively distinguished between mRS levels 0–1, 2, 3, and 4. The SIS Participation domain also distinguished between mRS levels 0–1, 2, and 3–4. However, the SF-36 SF scores were similar across mRS levels 0, 1, and 2, as well as levels 2, 3, and 4.

Conclusions: Compared with the SF-36 PF and SF domains, the SIS-16 and SIS Participation domains are better able to capture physical functioning and social well-being in patients following stroke.

***Corresponding author**

Sue Min Lai, PhD, MS, MBA, Professor of Epidemiology and Program Director, Kansas Statewide Cancer Registry, University of Kansas Medical Center, Kansas City, Kansas, USA.

Received: November 16, 2026; **Accepted:** November 18, 2026; **Published:** November 30, 2026

Introduction

The impact of stroke can be devastating, resulting in residual impairments in physical, psychological, and social functioning, which can significantly affect patients' daily lives [1–4]. Treatments for acute stroke have been developed to minimize brain damage, which generally occurs early after stroke onset. The most rapid functional improvements typically occur during the first month following stroke [3]. However, our understanding of the details of post-stroke recovery remains limited because of the wide range of disabilities experienced by stroke survivors.

Functional outcomes assessed using activities of daily living (ADL) scores have traditionally been among the most widely used measures of stroke recovery [2–7]. Accordingly, natural history studies of stroke and most acute stroke therapeutic trials have assessed ADL using established indices such as the Barthel Index (BI) [8]. The Modified Rankin Scale (mRS), which measures the degree of handicap rather than disability alone, has also been widely used as a primary outcome measure in acute stroke therapeutic trials [2,6–7,9–10]. Traditionally, BI scores of 95–100 and mRS scores of 0–1 or 0–2 have been selected by physicians and researchers as indicators of favorable outcomes in acute stroke therapeutic trials and assessments of healthcare quality [2–7,9–10].

However, the Barthel Index has a substantial ceiling effect, limiting its ability to distinguish between patients with relatively good functional outcomes. Similarly, although the mRS captures the degree of disability, it does not adequately assess health-related quality of life (HRQoL) [7]. The Short Form-36 (SF-36), a widely used generic instrument for assessing HRQoL, evaluates multiple dimensions of physical, psychological, and social functioning. Nevertheless, certain SF-36 domains demonstrate substantial floor and ceiling effects [11–13]. Although the SF-36 provides a comprehensive assessment of several HRQoL dimensions, it may not adequately characterize disabilities specifically associated with stroke [14]. Assessing outcomes in individuals following stroke is essential for both clinical practice and research; however, there remains no consensus regarding the most appropriate instrument for evaluating post-stroke outcomes in either setting.

The Stroke Impact Scale (SIS) has evolved from Version 1.0 to its current Version 3.0 and is widely used to evaluate the impact of stroke on patients' daily lives [11–12]. The SIS 3.0 demonstrates sound psychometric properties, including reliability, validity, and responsiveness to change. It assesses eight domains that characterize residual impairments in physical, psychological, and social functioning following stroke and its treatment. Furthermore, the instrument has been used in clinical drug trials to evaluate outcomes among stroke patients.

Methods

Clinical relevance in stroke outcome measurement can best be achieved by incorporating a framework based on the disablement process. The World Health Organization's International Classification

of Impairments, Disabilities, and Handicaps (ICIDH) provides a logical and comprehensive framework for classifying outcomes following stroke [1].

The 59-item Stroke Impact Scale (SIS) is the final version of the instrument used to assess the impact of stroke. It comprises eight domains: strength, hand function, activities of daily living (ADL), instrumental activities of daily living (IADL), mobility, communication, emotion, memory and thinking, and social participation. Our study team also evaluated the instrument's internal consistency and test-retest reliability [1,2].

The validity of the SIS domains was examined by comparing SIS scores with those obtained using established stroke-specific measures and by evaluating differences in SIS scores across levels of the Modified Rankin Scale (mRS) [7]. The mixed-model procedure was used to assess the responsiveness of SIS domain scores to changes over time [8].

The results of the mixed-model analysis identified five factors. One factor encompassed four physical domains: strength, hand function, mobility, and activities of daily living/instrumental activities of daily living. The remaining four factors represented emotion, communication, memory, and social participation. Therefore, the four physical domains may be combined into a single composite score, whereas emotion, communication, memory, and social participation should be assessed and scored as separate domains [8].

A total of 278 individuals who provided informed consent were recruited through the Kansas City Stroke Registry, which was supported in part by the National Institute on Aging Claude D. Pepper Older Americans Independence Center Grant [7]. Participants were recruited from 15 hospitals and four nursing homes or assisted-living facilities in the Kansas City metropolitan area.

Both the Kansas City Stroke Registry and the present study were approved by the Institutional Review Boards of the participating hospitals and the university. Patients were enrolled if they were within 28 days of their stroke diagnosis. To be eligible for participation in the stroke registry, patients were required to have a documented diagnosis of stroke based on the World Health Organization definition and to be at least 50 years of age at the time of stroke diagnosis [14].

Exclusion Criteria

Participants were excluded from the study if they met any of the following criteria:

1. Stroke onset more than 28 days before enrollment
2. Stroke resulting from subarachnoid hemorrhage
3. Pre-existing neurological deficits from a previous stroke
4. Life expectancy of less than 1 year
5. New York Heart Association (NYHA) Class IV heart failure
6. Residence outside the community before the stroke (e.g., institutionalized)
7. Lack of independence in basic activities of daily living (ADLs) before the stroke.
8. Residence more than 50 miles from a participating hospital
9. Presence of progressive or severe neurological disease, amputation, obtundation, or coma, or inability to follow a three-step command

For the present investigation, four domains were included in the analysis: the SIS-16 (16 items), SIS Social Participation (8 items), SF-36 Physical Functioning (PF) domain (10 items), and SF-36 Social Functioning (SF) domain (2 items).

All four domains were transformed to a standardized scale ranging from 0 to 100, with 0 representing the worst possible score and 100 representing the best possible score.

Accordingly, the floor effect was defined as a score of 0, indicating the lowest possible level of physical or social functioning. The ceiling effect was defined as a score of 100, indicating the highest possible level of physical or social functioning.

Results

A total of 278 stroke patients who provided informed consent to participate in the Kansas City Stroke Study were included in the analysis. Table 1 presents the demographic characteristics of the study participants. The mean age of the study population was 72.5 ± 10.1 years. Of the participants, 148 (53.2%) were female and 130 (46.8%) were male.

Regarding racial distribution, 234 participants (84.2%) were White, 40 (14.4%) were Black/African American, and one participant was Asian. Fifty-eight participants (21%) had completed college or postgraduate education. Detailed information regarding participants' demographic characteristics and stroke types at diagnosis is presented in Table 1.

Table 1. Demographic Characteristics of Study Participants (N = 278)

Demographic Characteristics	Study Participants (n = 278), Mean (SD) or n (%)
Age (years)	72.5 (10.2)
Sex	
Female	148 (53.2%)
Male	130 (46.8%)
Race	
Black	40 (14.4%)
White	234 (84.2%)
Other	4 (1.4%)
Education	
Grades 1–6	7 (2.5%)
Grades 7–9	27 (9.7%)
Grades 10–11	29 (10.4%)
High School/GED	157 (56.5%)
College	45 (16.2%)
Postgraduate	13 (4.7%)

A total of 261 patients (93.9%) had ischemic stroke (Table 2). The mean baseline Barthel Index score was 45 ± 27.6. The baseline clinical characteristics of the study participants are also presented in Table 2.

The mean SIS-16 and SF-36 Physical Functioning (PF) scores across the six levels of the Modified Rankin Scale (mRS), ranging from 0 to 5, are presented in Table 2. The mean SIS-16 and SF-36 PF scores were similar between mRS levels 0 and 1 but differed significantly from those observed at the other mRS levels. The mean scores also differed significantly among the remaining mRS groups ($P < 0.025$ for all comparisons; $P < 0.0001$ for most pairwise comparisons).

Table 2: Baseline Clinical Characteristics of Study Participants (N = 278)

Demographic and Clinical Characteristics	Cases (N = 278), Mean (SD) or n (%)
Stroke Type	
Ischemic	261 (93.9%)
Hemorrhagic	16 (5.8%)
Uncertain	1 (0.4%)
Baseline Clinical Assessment	
Baseline Barthel Index, Mean (SD)	45 (27.6)
Baseline Median NIHSS	6
Baseline NIHSS Categories	
0–5	134 (48.2%)
6–13	121 (43.5%)
14–21	18 (6.5%)
22 and above	3 (1.1%)
Not assessed	2 (0.7%)
Three-Month Follow-Up Assessment	
3-month MMSE	26 (3.9)
3-month Barthel Index	81 (22.5)
3-month Lawton IADL	20 (5.5)

Abbreviations: *NIHSS: National Institutes of Health Stroke Scale, MMSE: Mini-Mental State Examination, IADL: Instrumental Activities of Daily Living, SD: Standard Deviation.*

The mean SIS Participation and SF-36 Social Functioning (SF) scores across the six levels of the Modified Rankin Scale (mRS) are presented in Table 3. SIS Participation scores differed significantly across mRS levels 0–1, 2, and 3–4. The differences were statistically significant ($P < 0.0001$ for all pairwise comparisons), except for two comparisons: between mRS levels 0 and 3 ($P = 0.0021$) and between mRS levels 2 and 3 ($P = 0.0184$).

In contrast, the mean SF-36 SF scores were similar among mRS levels 0, 1, and 2, as well as among levels 2, 3, and 4. Better discriminant validity of the SIS-16 was descriptively demonstrated by its lower variability within each mRS level. Both the SIS Participation and SF-36 SF domains exhibited greater within-group variability across the mRS levels (Tables 2 and 3).

Table 3 presents the percentages of participants exhibiting floor effects (score of 0) and ceiling effects (score of 100) across the six levels of the Modified Rankin Scale (mRS) for the SIS-16 and SIS Social Participation domains, respectively.

Table 3: Percent Floor and Ceiling Effects: Comparison of SIS-16 and SF-36

Modified Rankin Scale (mRS)	n	SIS-16 Floor Score (0) %	SIS-16 Ceiling Score (100) %
0	10	0	10
1	61	0	13
2	88	0	1
3	65	0	0
4	52	0	0
5+	2	0	4

Abbreviations: *SIS: Stroke Impact Scale, SF-36: 36-Item Short Form Health Survey, mRS: Modified Rankin Scale.*

Among the 10 participants with an mRS score of 0, none received a score of 0 on the SIS-16, indicating the absence of a floor effect in this group. In contrast, all 10 participants with an mRS score of 0 achieved the maximum score of 100 on the SIS Social Participation domain, demonstrating a ceiling effect in this group.

Lastly, the mean SIS-16 and SF-36 scores across the different levels of the Modified Rankin Scale (mRS) are presented in Table 4.

Table 4: Scores of the SIS-16 and SF-36 by Levels of Modified Rankin Scale

Modified Rankin Scale	n	SIS-16 Mean ± SD	SIS-16 95% CI	SF-36 Mean ± SD	SF-36 95% CI
0	10	89 ± 9.7	82.1–95.9	68 ± 20.4	53.4–82.6
1	61	87 ± 11.1	84.2–89.8	81 ± 23.0	75.1–86.9
2	88	75 ± 13.7	72.1–77.9	43 ± 21.5	38.4–47.6
3	65	64 ± 16.0	60.0–68.0	31 ± 24.7	24.9–37.1
4	52	42 ± 15.8	37.6–46.4	12 ± 17.3	7.2–16.8
5*	2	15 ± 18.8	—	0 ± 0.0	—

Note: *The 95% confidence intervals are recalculated estimates based on the supplied summary statistics. ANOVA excluded the mRS 5 group because of its small sample size (n = 2).*

Discussion

The selection of outcome measures can significantly influence the assessment of the effectiveness of a new treatment or intervention. In clinical trials, the Modified Rankin Scale (mRS) and Barthel Index (BI) are commonly used to assess patient outcomes. However, there is no consensus on how these scales should be applied to determine outcomes in clinical trials. The present study examined recovery profiles and health-related quality of life among patients who achieved favorable outcomes, as defined by criteria based on the mRS and BI [2–7, 10].

Highly recovered stroke patients continue to experience significant residual disabilities in hand function, activities of daily living (ADL), instrumental activities of daily living (IADL), and social functioning compared with stroke-free, community-dwelling older adults, even after adjustment for age and comorbidities such as diabetes [20].

Functional recovery of the upper limb involves the ability to grasp, hold, and manipulate objects. These activities require the recruitment and complex coordination of muscle activity extending from the shoulder to the fingers. Despite recovery in other functional areas, upper-limb impairments persist in approximately 55%–75% of stroke patients 3–6 months after stroke. The hemiplegic upper limb is affected in many stroke patients, yet its functional limitations may not be adequately evaluated using traditional outcome measures.

The Stroke Impact Scale (SIS) captures persistent difficulties in hand function, ADL/IADL, and overall physical function (SIS-16), including among stroke patients who have traditionally been considered functionally independent. Patients' ability to care for themselves and live independently is an important aspect of post-stroke recovery that clinicians should assess comprehensively. Traditional measures, such as the Barthel Index (BI), may underestimate limitations in these areas.

Other important aspects of recovery, particularly social functioning, should be considered from the patients' perspectives, as they reflect their ultimate level of everyday performance and functioning [20-25]. Unfortunately, the Barthel Index (BI) and other commonly used outcome measures, such as the Modified Rankin Scale (mRS), provide limited or no information about these aspects. In addition to persistent physical limitations, stroke patients who are considered functionally independent three months after stroke may continue to experience social isolation [Lai]. Difficulties in regaining their previous levels of physical functioning can adversely affect patients' quality of life. Because of the ceiling effect inherent in the BI, stroke-related disabilities and their impact on quality of life may not be adequately captured by this measure.

In contrast, the Stroke Impact Scale (SIS) can identify differences in fine motor function (hand function) and social participation between stroke-free, community-dwelling older adults and stroke patients who are otherwise considered functionally independent. Therefore, an instrument such as the SIS, which assesses ADL, IADL, emotional well-being, communication, mobility, walking, and social participation, is recommended for comprehensively evaluating recovery after stroke.

Finally, the proxy version of the Stroke Impact Scale (SIS) can be used to assess stroke recovery when patients are unable to provide self-reported responses. However, patients must be able to follow three-step commands for the proxy version to be administered.

Furthermore, proxies were required to meet the following criteria:

- Have known the patient for at least one year
- See the patient at least once per week
- Be 18 years of age or older
- Have a Mini-Mental State Examination (MMSE) score of at least 16

Acknowledgements

The study was funded by the American Heart Association and the Kansas Claude D. Pepper Older Americans Independence Center (NIA-P60 AG 14635-03). Participating facilities in the greater Kansas City area included Baptist Medical Center, Bethany Hospital, VA Medical Center at Kansas City, Independence Regional Health Center, John Knox Village Care Center, Liberal Hospital, Life Care Center of Grandview, Menorah Medical Center, Mid-America Rehabilitation Hospital, Overland Park Regional Medical Center, Rehabilitation Institute, Research Medical Center, Shawnee Mission Medical Center, St. Luke's Medical Center, St. Joseph Health Center, Trinity Lutheran Hospital, and the University of Kansas Medical Center.

References

1. Roberts L, Counsell C (1998) Assessment of clinical outcomes in acute stroke trials. Stroke 29: 986-991.
2. Margaret Kelly-Hayes, Philip A Wolf, Carlos S Kase, Glen E Gresham, William B Kannel, et al. (1989) Time course of functional recovery after stroke: The Framingham Study. Journal of Neurologic Rehabilitation 3: 65-70.
3. Duncan PW, Wallace D, Studenski S, Lai SM, Johnson D (2001) Conceptualization of a new stroke-specific outcome measure: The Stroke Impact Scale. Topics in Stroke Rehabilitation 8: 19-33.
4. Duncan PW, Lai S M, V van Culin, Huang L, Clausen D, et al. (1999) Development of a comprehensive assessment toolbox for stroke. Clinics in Geriatric Medicine 15: 885-916.
5. Duncan PW, Wallace D, Lai SM, Johnson D, Embretson S, et al. (1999) The Stroke Impact Scale version 2.0: Evaluation of reliability, validity, and sensitivity to change. Stroke 30: 2131-2140.
6. Sooyeon Kwon, Pamela Duncan, Stephanie Studenski, Subashan Perera, Sue Min Lai, et al. (2006) Measuring stroke impact with SIS: Construct validity of SIS telephone administration. Quality of Life Research 15: 367-376.
7. Lai SM, Duncan PW (2001) Stroke recovery profile and the Modified Rankin assessment. Neuroepidemiology 20: 26-30.
8. Studenski SA, Wallace D, Duncan PW, et al. (2001) Predicting stroke recovery: Three- and six-month rates of patient-centered functional outcomes based on the Orpington Prognostic Scale. Journal of the American Geriatrics Society 49: 308-312.
9. Lai SM, Perera S, Duncan P, Bode R (2003) Physical and social functioning after stroke: Comparison of the Stroke Impact Scale and Short Form-36. Stroke 34: 488-493.
10. Duncan PW, Lai SM, Bode RK, Perera S, DeRosa J (2003) Stroke Impact Scale-16: A brief assessment of physical function. Neurology 60: 291-296.
11. Lai SM, Studenski S, Duncan PW, Perera S (2002) Persisting consequences of stroke measured by the Stroke Impact Scale. Stroke 33: 1840-1844.
12. Sue-Min Lai, Stephanie Studenski, Lorie Richards, Subashan Perera, Dean Reker, et al. (2006) Therapeutic exercise and depressive symptoms after stroke. Journal of the American Geriatrics Society 54: 240-247.
13. Wallace D, Duncan PW, Lai SM (2002) Comparison of the responsiveness of the Barthel Index and the motor component of the Functional Independence Measure in stroke. Journal of Clinical Epidemiology 55: 922-928.
14. Wade DT, Collin C (1988) The Barthel ADL Index: A standard measure of physical disability? International Disability Studies 10: 64-67.
15. De Haan R, Limburg M, Bossuyt P (1995) The clinical meaning of Rankin "handicap" grades after stroke. Stroke 26: 2027-2030.
16. John E Ware (1993) SF-36 Health Survey: Manual and Interpretation Guide. Available at: https://books.google.co.in/books/about/SF_36_health_survey.html?id=WJsgAAAAMAAJ&redir_esc=y.
17. Folstein MF, Folstein SE, McHugh PR (1975) "Mini-mental state": A practical method for grading the cognitive state of patients for the clinician. Journal of Psychiatric Research 12: 189-198.
18. Kasner SE (2006) Clinical interpretation and use of stroke scales. The Lancet Neurology 5: 603-612

19. Patricia García-Pérez, María Carmen Rodríguez-Martínez, Alejandro Gallardo-Tur, Encarnación Blanco-Reina, Carlos de la Cruz-Cosme, et al. (2024) Early occupational therapy intervention post-stroke: A randomized controlled trial. PLOS ONE 19: e0308800.
20. Aline Dias Brandão, Natasha Bertocco Teixeira, Maria Claudia Brandão, Milena Carlos Vidotto, José Roberto Jardim, et al. (2018) Translation and cultural adaptation of the Stroke Impact Scale 2.0 (SIS): A quality-of-life scale for stroke. São Paulo Medical Journal 136: 144-149.
21. Obaid Almalki, Mansour Abdullah Alshehri, Amir Abdel-Raouf El-Fiky, Ashraf Am Abdelaal, Jamal Hs Alzaidi, et al. (2019) Can the Stroke Impact Scale 3.0 detect cognitive impairments in patients with a recent stroke? Journal of Physical Therapy Science 31: 563-568.
22. Tsalta-Mladenov M, Andonova S (2021) Health-related quality of life after ischemic stroke: Impact of sociodemographic and clinical factors. Neurological Research 43: 553-561.
23. Pamela Duncan, Dean Reker, Sooyeon Kwon, Sue-Min Lai, Stephanie Studenski, et al. (2005) Measuring stroke impact with the Stroke Impact Scale: Telephone versus mail administration in veterans with stroke. Medical Care 43: 507-515.
24. Pamela W Duncan, Sue Min Lai, Denise Tyler, Subashan Perera, Dean M Reker, et al. (2002) Evaluation of proxy responses to the Stroke Impact Scale. Stroke 33: 2593-2599.
25. Duncan PW, Lai SM, Keighley J (2000) Defining post-stroke recovery: Implications for design and interpretation of drug trials. Neuropharmacology 39: 835-841.

Copyright: ©2026 Sue Min Lai.This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.