Physical and Social Functioning After Stroke
Comparison of the Stroke Impact Scale and Short Form-36

Sue-Min Lai, MS, MBA, PhD; Subashan Perera, PhD; Pamela W. Duncan, PhD; Rita Bode, PhD

Background and Purpose—This study evaluated assessments of physical functioning and social functioning using the Stroke Impact Scale (SIS) and Short Form-36 (SF-36) to characterize health-related quality of life for patients after stroke.

Methods—The SIS and SF-36 were administered to 278 stroke subjects ≈90 days after stroke. The SIS-16 and SF-36 Physical Functioning (PF) domain characterize physical function, whereas the SIS Participation and SF-36 Social Functioning (SF) domains characterize social function. Descriptive statistics and an analysis of variance were used to characterize physical and social functioning after stroke across levels of the modified Rankin Scale (MRS). Rasch analysis was used to compare the hierarchies and ranges of item difficulties in the SIS-16 and the SF-36 PF domains, as well as in the SIS Participation and the SF-36 SF domains.

Results—Item hierarchies for the SIS-16 and SF-36 PF domain demonstrate that the SIS-16 contains less difficult items that could differentiate physical function among patients with more severe limitations. Compared with the SF-36 SF domain, the item hierarchy for the SIS Participation domain contained more difficult items that could differentiate social function among patients who were more active. In contrast to SIS-16, the SF-36 PF has major floor effects. In contrast to SIS Participation, the SF-36 SF domain has major ceiling effects. Both SIS-16 and SF-36 PF were able to discriminate well among the MRS levels of 0 to 1, 2, 3, and 4. The SIS Participation domain was also able to discriminate across the MRS levels of 0 to 1, 2, and 3 to 4. On the other hand, the SF-36 SF was similar among MRS levels 0, 1, and 2 and among MRS levels 2, 3, and 4.

Conclusions—Both the physical and participation subscales of the SIS cover a wider range of item difficulty than their counterparts from the SF-36. Compared with the SF-36 PF and SF domains, the SIS-16 and SIS Participation are better able to capture physical functioning and social well-being in patients with strokes. (Stroke. 2003;34:488-493.)

Key Words: outcome ■ quality of life ■ stroke ■ stroke assessment

The impact of stroke can be devastating, leaving a person with residual impairment of physical, psychological, and social functions.1–4 Treatments for acute stroke have been developed that attempt to minimize brain damage and improve outcomes after ischemic strokes. In drug therapeutic trials, the Barthel Index5 and the modified Rankin Scale (MRS)6 are commonly used to assess outcomes, but they have shortcomings.7 The Barthel Index assesses basic activities of daily living (ADL) but suffers from a severe ceiling effect, and the MRS captures disability but not health-related quality of life.8–10 Other epidemiological studies of stroke have used the Short Form-36 (SF-36),11 which is a widely used generic health-related quality of life instrument that assesses physical, psychological, and social functions12,13 but was found to have high floor and ceiling effects in some domains.14

A recently developed stroke-specific instrument, the Stroke Impact Scale (SIS), was designed to comprehensively assess stroke-related outcomes.15–17 The SIS assesses 8 domains, including strength, hand function, ADL and instrumental ADL (IADL), mobility, emotion, memory, communication, and participation. This comprehensive instrument has been found to accurately assess recovery after stroke.16–18 The SIS Participation domain and the SIS-16, which includes selected items from the Hand Function, ADL/IADL, and Mobility domains, can be used as stand-alone scales to assess social and physical function. The SIS-16 has previously been compared with the Barthel Index and found to be sensitive to functional differences across all levels of stroke severity as characterized by MRS levels 0 to 5.17 This study examined item difficulty and the response patterns of persons with stroke to the items in the physical and social function domains of both the SIS and SF-36 using the Rasch analytical technique.19 Also, rates of floor and ceiling effects (percentage of cases with minimum and maximum scores) and their

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ability to discriminate poststroke impairments in physical and social functioning among individuals with differing levels of stroke severity were investigated.

**Methods**

Two hundred eighty-eight subjects who had consented to participate in this study were recruited through the Kansas City Stroke Registry. The Kansas City Stroke Registry, funded by the National Institute of Aging Claude D. Pepper Older Americans Independence Center Grant, enrolls stroke patients from 15 Kansas City metropolitan area hospitals and 4 nursing homes/assisted-living facilities. 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. Potential patients were identified in each of the 19 recruitment sites through review of daily admission and discharge records and by referrals from unit-based nurses. To be eligible for participation in the stroke registry, a patient had to have had a documented diagnosis of stroke and been ≥50 years of age. For the purposes of this study, the World Health Organization definition of stroke was used. A stroke was defined as symptoms of rapid onset and of vascular origin reflecting a focal disturbance of cerebral function, excluding isolated impairment of higher function, and these deficits must have persisted for >24 hours. In addition, patients could not have had any of the following exclusion criteria: stroke onset >28 days, stroke resulting from subarachnoid hemorrhage, deficits from a previous stroke, life expectancy of <1 year, New York Heart Association class IV heart failure, dwelling outside the community before the stroke, not independent in basic ADL before the stroke, residence >50 miles from participating hospital, progressive or severe neurological disease, amputation, obtunded, comatose, or unable to follow a 3-step command.

At registry enrollment, patients’ demographics, stroke types, prior functional status, and stroke severity as judged by the National Institutes of Health Stroke Scale and the Barthel Index were assessed by interview and examination by research nurses and physical therapists using standardized questionnaires. Approximately 90 days after stroke, all registry participants were again assessed in terms of basic ADL and IADL using the Barthel Index and Lawton IADL. For the present investigation of the SIS and SF-36, all patients were assessed in their homes or nursing facilities by a master’s level research associate between 90 and 120 days after stroke onset. In addition, patients could not have had any of the following exclusion criteria: stroke onset >28 days, stroke resulting from subarachnoid hemorrhage, deficits from a previous stroke, life expectancy of <1 year, New York Heart Association class IV heart failure, dwelling outside the community before the stroke, not independent in basic ADL before the stroke, residence >50 miles from participating hospital, progressive or severe neurological disease, amputation, obtunded, comatose, or unable to follow a 3-step command.

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For the present investigation, only the SIS-16 (16 items) SIS Social Participation (8 items), the 10-item SF-36 Physical Functioning (PF), and the 2-item SF-36 Social Functioning (SF) are included in the analysis. These 4 domains have been transformed to a scale with total scores ranging from 0 to 100, with 0 being the worst possible score and 100 being the best possible score. As such, the floor effect is defined as a score of 0, indicating that patients are unable to perform physical functioning (or social functioning), and the ceiling effect is a score of 100, implying that patients are able to perform all physical activities (or best social functioning).

Items from the SF-36 PF10 and the SIS-16 and from the SF-36 SF and SIS Participation domains were cocalibrated to examine their functioning relative to each other. Cocalibration consists of the simultaneous analysis of the responses of persons in a single sample to items in ≥2 instruments. It is similar in procedure, but not in intent, to common item equating in which only a subset of items is common across ≥1 sample. In common item equating, the intent is to place total scores from each instrument on a common scale. In cocalibration, the intent is to place estimates of item difficulty for items in >1 instrument on a common scale. In the SIS/SF-36 analysis, cocalibration was used to examine the extent to which the items in the SIS-16 and SIS Participation domain covered the same or a wider range of difficulty than the items in the SF-36 PF and SF domains. Rasch analysis, using WINSTEPS version 3.31, was used to transform the ordinal raw scores into interval-level measures to illustrate the hierarchy of items in both instruments (now on a common scale) from least to most difficult to perform. In Rasch analysis, both person ability and item difficulty are expressed as a logit, the natural logarithm of the odds of a person being able to perform a particular task. The odds of a person being able to perform a particular task is the ratio of the probability of the person being able to perform the task to the probability of the person not being able to perform the task. Logits of greater magnitude represent increasing item difficulty.

Descriptive statistics were also used to summarize demographics, stroke characteristics, and stroke severity data. To evaluate the discriminant validity of PF and SF domains of the SIS and SF-36, mean scores for each domain to the groups (levels) defined by MRS were compared by use of analysis of variance with a Tukey-Kramer correction for multiple comparisons. We also assessed concurrent validity with total scores ranging from 0 to 100, with 0 being the worst possible score and 100 being the best possible score. As such, the floor effect is defined as a score of 0, indicating that patients are unable to perform physical functioning (or social functioning), and the ceiling effect is a score of 100, implying that patients are able to perform all physical activities (or best social functioning).
validity by examining the relationships between standard measures of stroke outcomes and these 4 domain scores, when appropriate, with Pearson correlation coefficients. SAS version 8.1 was used for all statistical analyses except cocalibration of item difficulties.

**Results**

The demographic and stroke characteristics of the 278 patients who consented to participate in this study are shown in Table 1. The SIS-16 scores (mean, 69; SD, 21.4) correlated well ($r=0.79$) with the SF-36 PF scores (mean, 39; SD, 27.8). Similarly, the SIS Participation scores correlated moderately well ($r=0.65$) with the SF-36 SF scores (SIS: mean, 57; SD, 26.7; SF-36: mean, 66; SD, 27.9). The Pearson correlation coefficients between SIS-16, SF-36 PF, SIS Participation, and SF-36 SF were $0.49$, $0.45$, $0.48$, and $0.34$, respectively. Similarly, the Pearson correlation coefficients between the 3-month poststroke Barthel Index scores and the SIS-16 and SF-36 PF scores were 0.75 and 0.55, respectively. However, the Pearson correlation coefficients between the 3-month poststroke Lawton IADL scores and the SIS Participation and SF-36 SF scores were substantially lower: 0.47 and 0.34, respectively.

Simultaneous maps of the item hierarchies for the SIS-16 and the SF-36 PF (Figure 1) demonstrate that both SIS-16 and SF-36 PF have a good spread of item difficulty, but only the SIS-16 has incorporated easier items (as indicated by smaller logit values) that are capable of measuring lower levels of physical functioning in patients with severe stroke. Similar simultaneous maps of the item hierarchies for the SIS Participation and the SF-36 SF domains (Figure 2) show that the SIS Participation domain has a good spread of item difficulty, whereas the SF-36 SF domain does not. The 2 items in the SF-36 subscale basically measures the same level of item difficulty, leading to severe ceiling effects and an inability to discriminate among more active patients.

The mean SIS-16 and SF-36 PF scores across 6 levels of the MRS (0 to 5) are shown in Table 2. The mean scores of the SIS-16 and SF-36 PF were similar between MRS levels 0 and 1 but were significantly different from all the other MRS groups, as were the differences between means of the remaining MRS groups with each other ($P<0.025$ for all, $P<0.0001$ for most pairwise comparisons). The mean SIS Participation and SF-36 SF scores across the 6 MRS levels are shown in Table 3. SIS Participation significantly differed across MRS 0 and 1, 2, and 3 levels. The associated significant values were $P<0.0001$ for all pairwise comparisons except 2 values of $P=0.021$ and $P=0.0184$, which were observed between MRS 0 and 3 and MRS 2 and 3, respectively. On the other hand, mean scores of SF-36 SF were similar among MRS levels 0, 1, and 2, and among MRS levels 2, 3, and 4. Better discriminant validity in SIS-16 was descriptively shown by smaller variability within each level of the MRS. Both the SIS Participation and SF-36 SF domains have greater variability within each level of the MRS (Tables 2 and 3).

The percentages of cases with floor and ceiling effects (those at the minimum and maximum scores for each scale)
are shown in Table 4. For example, the percentages of cases with floor and ceiling effects for SIS-16 were 0% and 4% compared with 9% and 1%, respectively, for the SF-36 PF domain. The SF-36 PF suffered floor effects in patients with MRS levels 4 and 5, and the SF-36 SF domain showed major ceiling effects.

### Discussion

Adequate capturing of the physical and psychosocial well-being of stroke patients is critical in assessing effectiveness of therapeutic programs for stroke. Yet, commonly used outcome measures like the Barthel Index and MRS are limited in their ability to assess basic ADL and disability but not health-related quality of life. Although the SF-36 has been widely used in recent years to capture health-related quality of life after stroke, the use of the SF-36 PF and SF scores is not without criticism when applied to, for example, severe stroke populations. To address these limitations, the SIS-16 was designed to better capture the broad range of poststroke physical limitations, including hand function, ADL, IADL, and mobility. As shown in this study, the SIS-16 also has the benefit of not suffering from ceiling and floor effects. Similarly, the SIS Participation domain adequately assesses the ability of a wide variety of poststroke patients to participate in the activities that are meaningful to their life without some of the limitations of the SF-36 SF domain.

![Figure 2. Item map for SIS Participation and SF-36 SF.](image)

### TABLE 2. Scores of the SIS-16 and SF-36 PF by the Levels of Modified Rankin Scale

<table>
<thead>
<tr>
<th>Modified Rankin</th>
<th>SIS-16</th>
<th>SF-36 PF</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10</td>
<td>89±9.7</td>
</tr>
<tr>
<td>1</td>
<td>61</td>
<td>87±11.1</td>
</tr>
<tr>
<td>2</td>
<td>88</td>
<td>75±13.7</td>
</tr>
<tr>
<td>3</td>
<td>65</td>
<td>64±16.0</td>
</tr>
<tr>
<td>4</td>
<td>52</td>
<td>42±15.8</td>
</tr>
</tbody>
</table>

### TABLE 3. Scores of the SIS Participation and SF-36 SF by the Levels of Modified Rankin Scale

<table>
<thead>
<tr>
<th>Modified Rankin</th>
<th>SIS Participation</th>
<th>SF-36 SF</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10</td>
<td>76±23.2</td>
</tr>
<tr>
<td>1</td>
<td>61</td>
<td>80±19.3</td>
</tr>
<tr>
<td>2</td>
<td>88</td>
<td>59±21.8</td>
</tr>
<tr>
<td>3</td>
<td>65</td>
<td>47±24.0</td>
</tr>
<tr>
<td>4</td>
<td>52</td>
<td>40±25.2</td>
</tr>
</tbody>
</table>

*This group was not included in the ANOVA or CI computations due to a small sample size (n=2).
In a previous article, we demonstrated that the SIS-16 incorporated more complex activities such as performing heavy household chores (eg, vacuuming and doing laundry), walking fast, and walking 1 block to minimize ceiling effects. In the present analysis, we show that the SIS-16 also incorporated less difficult yet essential activities like bowl control and standing without losing balance. The inclusion of these items helps the SIS-16 avoid floor effects that have been observed when the SF-36 PF is used to assess stroke patients with severe disability. Because of the preponderance of items with high levels of difficulty, the SF-36 PF suffers significant floor effects when used with this type of sample. For example, 37% of the 52 subjects with an MRS of 4 scored 0 in their SF-36 PF assessment (Table 4).

Social functioning, as operationally defined in these instruments, is an integral part of assessing recovery after stroke. However, the SF-36 SF domain was unable to capture levels of social functioning in stroke patients because of the limited number of items (2 items) and the relative ease of endorsing these items, both of which have the same level of difficulty (Figure 2). These 2 items have a level of difficulty equivalent to the item “spiritual/religious activities” in the SIS Participation domain. In contrast, the SIS Participation domain includes 8 items that have wide ranges of activities to characterize patients’ social functioning.

This study also has some limitations. Our sample is potentially biased from the true population of all stroke survivors; it is hospital based and limited to persons who were previously community dwelling and independent in personal care. It is likely to underrepresent the most severe strokes because our eligibility criteria excluded persons who were obtunded or comatose at entry. The predominance of mild to moderate strokes in this study compared with the universe of stroke survivors is supported by our data; this study had a lower death rate than the Jorgenson et al11 population-based study in Copenhagen. Such population-based studies would be expected to provide the best estimates of recovery in the true population of stroke survivors, although they also suffer from detection limited to hospitalization. Thus, our results are least applicable to persons who have had very severe or very mild strokes; very severe strokes with coma were excluded, and very mild strokes for which patients were never hospitalized would not have been detected by our recruitment strategy. Our results are relevant to most stroke survivors, who would be hospitalized initially and enter institutional rehabilitation, skilled nursing units, or community-based programs such as day hospital or home health, typically 3 to 14 days after the initial event.

In summary, SIS-16 and the SIS Participation domain discriminated well across levels of the MRS. This study has demonstrated that SIS-16, in contrast to SF-36 PF, and SIS Participation, in contrast to SF-36 SF, can adequately assess patients’ physical and social well-being.

Acknowledgments

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References


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