

PAPER

The Depression Intensity Scale Circles (DISCs): a first evaluation of a simple assessment tool for depression in the context of brain injury

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Objective: To assess the validity, responsiveness, and test–retest reliability of DISCs (Depression Intensity Scale Circles) as a simple screening tool for depression in patients with cognitive or communicative deficits following acquired brain injury.

Design: Cohort analysis of consecutive patients entered into an integrated care pathway for screening and management of depression in the context of rehabilitation.

Setting: Regional neurological rehabilitation service in the UK.

Participants: 114 patients with complex disabilities caused by acquired brain injury (mean (SD) age, 42.8 (14.5) years).

Main outcome measures: DISCs (a graphic rating scale depicting six circles with increasing proportion of dark shading), Numbered Graphic Rating Scale (NGRS), Yale single question ('Do you often feel sad or depressed'), Beck Depression Inventory-II (BDI-II), DSM-IV criteria for depression.

Results: At initial assessment the DISCs correlated with total BDI-II scores (Spearman $\rho = 0.66$, $p < 0.001$), NGRS ($\rho = 0.87$, $p < 0.001$), and DSM-IV ($\rho = 0.59$, $p < 0.001$). A DISCs score ≥ 2 identified depression (major or minor) according to DSM-IV criteria with 60% sensitivity, 87% specificity, 75% positive predictive value, and 77% negative predictive value. Test–retest reliability after 24 hours ($n = 66$) showed 'excellent' level of agreement (weighted $\kappa = 0.84$). In 45 patients who received intervention for depression, the DISCs showed a significant change in response to treatment (Wilcoxon; $p < 0.001$).

Conclusions: DISCs had acceptable convergent validity, reliability, and responsiveness as a simple graded tool for screening and assessment of depression in patients with complex disabilities following acquired brain injury. It warrants further investigation in patients with more profound language and cognitive deficits for which it is primarily intended.

Depression is common following acquired brain injury of any cause (stroke, trauma, inflammation, anoxia, and so on) and is associated with poor outcomes.^{1,2} The reported frequency varies depending on the context and the indices used to define depression, but most studies record depression in approximately one third of patients (range ≈ 10 –50%).³

Various interventions are available for treatment of depression following acquired brain injury (ABI), but the demonstration of their effectiveness depends on having a valid and reliable means to measure change in mood. The assessment of depression in this context is problematic for several reasons:

- People with ABI often have cognitive deficits which interfere with their ability to recall and report their symptoms.
- They may also have language and visuo-spatial difficulties which affect their ability to respond to standardised instruments which use verbal or visual analogue scale questions.⁴
- Symptoms arising from the ABI itself or from hospital admission may mimic the somatic features of depression (such as tearfulness, poor concentration, loss of appetite, disturbed sleep pattern, and so on) and thus confound the use of many of the standardised measures for depression which include these characteristics. Scales such as the Hospital Anxiety and Depression Scale (HADS), which are specifically designed for use in a hospital inpatient

population, are only partially successful in overcoming these problems.⁵

The diagnosis of depression is most commonly made by application of the criteria defined in the American Psychiatric Association *Diagnostic and Statistical Manual of Mental Disorders*, fourth edition (DSM-IV),⁶ although the requirement for symptoms to be present for three months may be waived in the context of physical illness. The DSM-IV criteria are normally applied through a structured interview (the Present State Examination). For the reasons given above, however, many patients with brain injury are not able to participate in a detailed structured interview, and in any event, features of the underlying brain injury can serve to confound the diagnosis. Verbally based self completed questionnaires such as the Beck Depression Inventory (BDI)⁷ are commonly used to define different categories of severity of depression,^{8–10} but may not be accessible by patients with language and cognitive deficits. Not only are individuals often unable to complete the questionnaire independently, but even when items are presented in a suitably adapted form during one to one interview, they may be unable to respond meaningfully or reliably.

Abbreviations: ABI, acquired brain injury; BDI, Beck Depression Inventory; DISCs, Depression Intensity Scale Circles; DSM, *Diagnostic and Statistical Manual of Mental Disorders*; FIM+FAM, Functional Independence Measure and Functional Assessment Measure; ICP, integrated care pathway; NGRS, Numbered Graphic Rating Scale

Because of these difficulties, some investigators have suggested that the use of a simple screening question, such as the Yale question "Do you often feel sad or depressed?"¹¹ may be as accurate as the application of more formal scales such as the Geriatric Depression Scale.¹² However, this simple dichotomous output does not allow for graded evaluation of depression in a situation where depressed mood improves with treatment, but does not remit completely.

Visual analogue scales in various designs have been used to elicit graded responses for a variety of symptoms. These include the Visual Analogue Mood Scale (VAMS)^{13,14} and the Visual Analogue Self Esteem Scale (VASES).¹⁵ But even these can prove problematic for stroke patients, who may have difficulty in perceiving the spatial relations of the scale.^{4,16} Vertical scales have been advocated over horizontal scales^{17,18} and offer a particular theoretical advantage in stroke patients where left sided neglect may compromise the ability to perceive the full length of a horizontal scale. The addition of numbered increments along a 10 cm line¹⁹ may help by providing additional anchor points for people with intact numeracy skills, but some patients with severe deficits may require even simpler tools.

Other instruments have used pictures to avoid the need for words or numbers. The Faces Pain Scale is a pictorial scale with a series of seven faces showing increasing features of distress, which has been developed for use with children²⁰ and evaluated in an elderly population.²¹ However, visuospatial deficits in brain injured patients may lead to misinterpretation of the facial expression, for example to reflect other emotions such as anger or rage.²²

The Scale of Pain Intensity (SPIN) has been designed specifically for this group of patients with cognitive and communicative problems.^{22,23} It is a six point vertical visual scale depicting six circles with increasing proportion of shading, coloured red for association with pain. The Depression Intensity Scale Circles (DISCs) is based on the same design, except that the circles are coloured dark grey for association with low mood. It is designed to be a very simple intuitive tool for graded assessment of depressed mood in people with ABI who may have difficulty in completing conventional assessments. The purpose of this study was to carry out an initial evaluation of validity, reliability, and responsiveness of the DISCs in the assessment of depression in a group of patients with severe complex disabilities following acquired brain injury, and to compare its performance with a gold standard and with a more conventional numbered graphic rating scale.

METHODS

The development and evaluation of our integrated care pathway (ICP) for the coordinated assessment and management of depression in patients with severe complex disabilities, and its use to evaluate the effects of treatment, have been reported previously.^{24,25}

The care pathway includes the routine use of a structured assessment for depression in patients with ABI, using various standardised instruments. Systematic screening and enrolment in the ICP for all patients engaged in the service provides a well documented consecutive cohort sample for comparative evaluation. The assessment tools are administered, in a standardised order, by the unit's neuropsychology team, who are specifically trained in the use of these tools. The current assessment procedure is as follows:

(1) The individual's ability to make reliable "yes/no" responses is first established by asking simple questions to elicit both "yes" and "no" answers accurately and consistently.

(2) The individual is then asked the Yale question, "Do you often feel sad or depressed"?

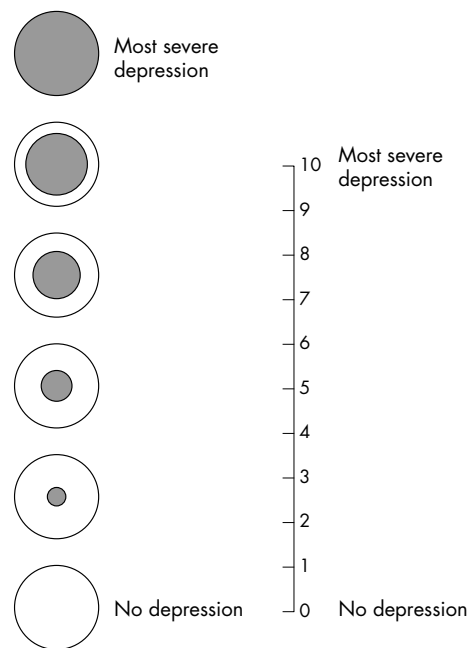


Figure 1 The Numbered Graphic Rating Scale (NGRS) and the Depression Intensity Scale Circles (DISCs) are displayed on separate laminated cards. The NGRS measures 10 cm with numbered increments every 1 cm. The DISCs measures 15 cm from the centre of the bottom circle to the centre of the top circle, each circle being 2 cm in diameter. A version with pictorial anchors is also available. (The DISCs is reproduced from the original with copyright permission from Professor Lynne Turner-Stokes, Northwick Park Hospital.)

(3) For those able to respond, the Beck Depression Inventory (BDI-II) is administered in a semistructured interview based on the BDI-II questions which have been adapted (with permission from the publishers) into a large print format for people with visual and attentional problems.

(4) The DSM-IV diagnosis is ascertained during the same structured interview from the information used to complete the BDI-II, with supplementary questions as appropriate to identify the presence or absence of DSM-IV criteria.

(5) DISCs and the Numbered Graphic Rating Scale (NGRS) are administered in random order by the method described below.

(6) For patients unable to respond to any of these, depression is assessed by structured interview of the treating team, using the Stroke Aphasic Depression Questionnaire.²⁶

Depression Intensity Scale Circles (DISCs)

DISCs is a six point ordinal graphic rating scale (score range 0 to 5), depicting six circles with an increasing proportion of dark shading (fig 1). The precise method of administration is adapted to suit the individual's cognitive and communicative abilities, but contains the following steps:

- The DISCs is placed in front of the patient in good light, and their ability perceive the whole range of the scale is established by asking them to point to each circle in turn.
- The following explanation is reinforced by gesture or pictures as appropriate:
 - This is a scale for measuring sadness or depression. The grey circles show how sad or depressed you feel.
 - The bottom circle [indicate clear circle] shows no sadness or depression.

Table 1 Cases of depression in this cohort, as identified by the BDI-II and DSM-IV criteria and by the Yale question

DSM-IV		BDI-II		Yale question	
Non-cases					
No depression	65 (60.2%)	None—minimal (score 0 to 13)	70 (64.8%)	“No”	66 (58%)
Cases of depression					
Mild	19 (17.6%)	Mild (14 to 19)	19 (11.1%)	“Yes”	47 (41%)
Major	24 (22.2%)	Moderate (20 to 28)	21 (19.4%)		
		Severe (29 to 65)	5 (4.6%)		
Total cases	43 (39.8%)		38 (35.1%)		47 (41%)

BDI, Beck Depression Inventory; DSM, Diagnostic and Statistical Manual of Mental Disorders.

- The top circle [indicate completely shaded circle] shows sadness or depression as bad as it can be.
- As you go from the bottom to the top circle [point to each circle ascending the scale] you can see that sadness or depression is becoming more and more severe.
- Which of these circles shows best how sad or depressed you feel today?

The Numbered Graphic Rating Scale (NGRS)

Many patients have become used to being asked to rate their symptoms out of 10, and the NGRS lays the numbers out in a visual form, presenting an accessible scale for those who are able to use it (fig 1). The NGRS is administered using a similar explanation to that for the DISCs, except that the individual is asked to indicate the highest, lowest, and midpoint on the scale (again confirming their ability to perceive the whole scale), before indicating their current level of depression.

Subjects and setting

The Regional Rehabilitation Unit at Northwick Park Hospital provides a regional service for younger adults (16–65 years) with severe complex disability following ABI. This patient group by definition has physical, cognitive, and communication deficits to some degree, and we have recorded a high incidence of depression.²⁴ The unit routinely applies standardised functional assessment using the functional assessment measure (UK FIM+FAM) for the assessment of physical, cognitive, and communicative function.²⁷

In this cohort analysis of data from 114 patients with acquired brain injury, admitted between April 2002 and June 2004, “cases” of depression were defined using the DSM-IV

criteria as the gold standard. For the purposes of comparison, DSM-IV categories were given the following ordinal rating: 0 = no depression, 1 = minor depression, 2 = major depression. The BDI-II was applied as the gold standard for *graded* measurement of depression, against which the performance of the DISCs and the NGRS was compared.

Test–retest reliability

The regional rehabilitation service provides both inpatient and outreach rehabilitation to a catchment radius of up to 70 miles (110 km). Not all subjects were in attendance on two consecutive days, so it was not feasible to obtain repeat data in all cases, but in 66 subjects the DISCs and the NGRS were repeated 24 hours later, by the same assessor.

Assessment of responsiveness to change

From the initial assessment, a subgroup of 45 patients (39%) was found to have significant depression requiring intervention, which was administered according to the integrated care pathway. These interventions involved drug treatment, counselling and support depending on the individual’s need, preference, and capabilities. This offered the opportunity to assess responsiveness of the DISCs to change. For this subgroup, the DISCs, NGRS, BDI-II, and DSM were assessed at the beginning and end of treatment, with a median interval of eight weeks (interquartile range (IQR) 4 to 10) between the assessments.

Statistics and data handling

Data were extracted from the unit’s computerised database and transferred into SPSS version 11.5 for analysis. The tools used in this study all provide data at ordinal level, so non-parametric statistics were applied throughout.

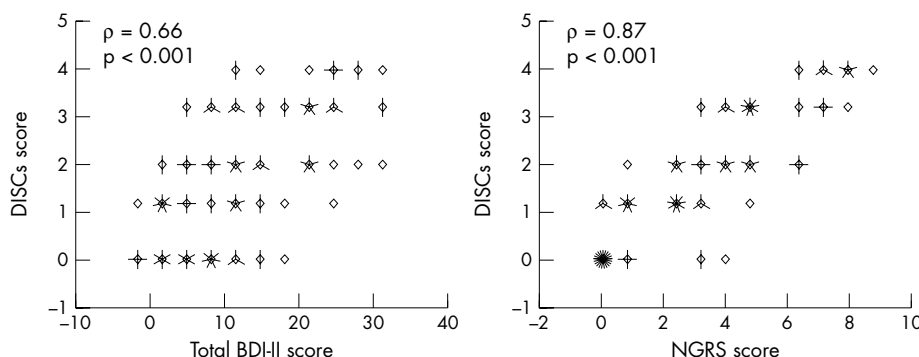


Figure 2 Spearman rank correlation between the DISCs score and BDI-II and NGRS scores. The markers in these graphs represent “sunflowers”, where each petal represents one pair of data. For example, \diamond indicates one pair of data at that point, while a six petalled “flower” indicates six pairs. BDI, Beck Depression Inventory; DISCs, Depression Intensity Scale Circles; NGRS, Numbered Graphic Rating Scale.

Table 2 Concurrent validity: Spearman rank correlations (ρ) between the DISCs, the NGRS, the BDI-II and the DSM-IV at initial assessment

Scale	DISCs*	NGRS*	BDI-II
DISCs	–	–	–
NGRS	0.87	–	–
BDI-II	0.66	0.65	–
DSM-IV	0.59	0.54	0.58

*All significant at $p < 0.001$.

BDI, Beck Depression Inventory; DISCs, Depression Intensity Scale Circles; DSM, *Diagnostic and Statistical Manual of Mental Disorders*; NGRS, Numbered Graphic Rating Scale.

Validity

Convergent validity of the DISCs was tested through two routes: *concurrent validity* was tested against BDI-II and compared with the numbered graphic rating scale (NGRS) using a Spearman rank correlation; *predictive validity* was tested by the sensitivity, specificity, and positive and negative predictive value of a DISCs rating of ≥ 2 to identify cases of depression as determined by DSM-IV. The DISCs was compared in this respect with the simple Yale question, with the NGRS taking the equivalent cut off point of 4/10, and with the BDI-II (score ≥ 14).

Reliability

Agreement between repeat scores ($n = 66$) was tested using quadratic weighted Cohen's κ tests.

Responsiveness to change

This was tested in 44 patients by comparing pretreatment and post-treatment measurements using the Wilcoxon signed rank test. Change scores for the DISCs were correlated with change in NGRS and in BDI-II scores using a Spearman rank correlation.

Ethics

Ethical permission for the research elements of the study including the screening, assessment, and treatment of patients with depression on the regional rehabilitation unit at Northwick Park Hospital was granted by the Harrow research ethics committee. Patients gave their informed consent to any treatment offered.

RESULTS

The mean (SD) age of the patient sample was 42.8 (14.5) years. The male to female ratio was 4:3. Seventy six patients (67%) had had a stroke: 32 (28%) right hemisphere, 26 (23%) left hemisphere, and 18 (16%) posterior or bilateral. Twenty (18%) had brain injury from trauma, and 17 (15%) had other neurological conditions, including inflammatory and anoxic damage. The median time since onset was 12 weeks (IQR 7 to 20). FIM+FAM assessments of communicative and cognitive ability were available in 84 patients and showed moderate to severe overall levels of impairment. Median cognitive

subscale score was 25 (IQR 20 to 32 (an unaffected score would be 35)), and median communicative subscale score was 26 (IQR 21 to 33) (unaffected score again 35).

As noted above, the diagnosis of depression following acquired brain injury can be difficult, and as the various tools all measure slightly different criteria, agreement is not expected to be perfect. The frequency of cases of depression as identified by the DSM-IV criteria, the BDI-II, and the Yale question are shown in table 1.

There was a "good" level of agreement between the BDI-II and the DSM criteria ($\kappa = 0.54$) in identifying cases, but the Yale question showed somewhat lower levels of agreement with the DSM-IV criteria ($\kappa = 0.41$) and with the BDI-II ($\kappa = 0.43$). Nevertheless, all were highly significantly associated (χ^2 , $p < 0.001$).

At initial assessment for the total group ($n = 114$), the median DISCs score was 2 (IQR 0 to 3, range 0 to 5); the median NGRS was 3 (IQR 1 to 5, range 0 to 10) and the median BDI-II was 10 (IQR 5 to 19, range 0 to 40). Concurrent validity was tested by comparing the DISCs with the BDI-II and the NGRS. Figure 2 shows the relation between the scales, and table 2 confirms the strong correlations between these three instruments and with the DSM-IV.

The results for predictive validity are shown in table 3. A DISCs score of ≥ 2 and an NGRS score of ≥ 4 performed almost equally in identifying cases of depression in relation to the DSM criteria. This meant that a DISCs score ≥ 2 identified nine cases which were false positives according to DSM-IV criteria, but missed 18 as false negatives. However, both graded scales fared better than the Yale question overall.

Repeat application ($n = 66$) of the two rating scales after a 24 hour interval showed similar levels of agreement for the DISCs (weighted $\kappa = 0.84$) and for the NGRS (weighted $\kappa = 0.84$), both of which equate to "excellent" agreement according to the classification described by Fleiss in 1981.²⁸

In the subgroup of this study population ($n = 45$) who were identified as being depressed and requiring treatment, the initial scores were somewhat higher than for the group as a whole, as would be expected. Table 4 give the starting and change scores for the various measures following treatment. All instruments showed a significant change. The change in DISCs score correlated significantly with change in NGRS (Spearman $\rho = 0.77$, $p < 0.001$) and with change in total BDI-II score ($\rho = 0.38$, $p < 0.01$).

DISCUSSION

The primary purpose for development of the DISCs was to achieve an accessible scale for patients with more severe cognitive and communicative problems who may have difficulty in completing other assessment tools, or who may be unable to recognise numbers and perceive a 10 cm line. Previous studies in our severely impaired population suggest that a quarter to one third of patients may have difficulty in completing standard visual analogue scales accurately.⁴ Work is ongoing, but preliminary study with our related scale, the SPIN (the design on which the DISCs is based), suggests that

Table 3 Predictive validity of the DISCs, NGRS, Yale question, and BDI-II against the DSM-IV criteria for case diagnosis of depression ($n = 114$)

	DISCs score ≥ 2	NGRS score ≥ 4	Yale question	BDI-II score ≥ 14
Sensitivity	60%	64%	68%	74%
Specificity	87%	85%	73%	80%
Positive predictive value	75%	74%	62%	69%
Negative predictive value	77%	78%	78%	84%

BDI, Beck Depression Inventory; DISCs, Depression Intensity Scale Circles; DSM, *Diagnostic and Statistical Manual of Mental Disorders*; NGRS, Numbered Graphic Rating Scale.

Table 4 Responsiveness: pretreatment and post-treatment evaluation and change scores following treatment (n = 45)

Instrument	Score (median (IQR))		Change in rank			z Score	p Value
	Initial	Post -treatment	–	+	=		
DISCs	3 (2 to 4)	2 (1 to 3)	27	7	11	–3.5	<0.001
NGRS	5 (4 to 7)	3 (1 to 5)	28	6	11	–4.1	<0.001
BDI	19 (13 to 26)	11 (7 to 16)	36	7	2	–4.4	<0.001
DSM category	1 (0 to 2)	0 (0 to 1)	23	3	19	–3.3	< 0.001

BDI, Beck Depression Inventory; DISCs, Depression Intensity Scale Circles; DSM, *Diagnostic and Statistical Manual of Mental Disorders*; NGRS, Numbered Graphic Rating Scale.

at least a small number of patients may be able to access this type of intuitive visual scale when they are unable to respond to any other type of questionnaire or visual analogue scale.²²

However, in the absence of a gold standard for comparison in that specific context, it was first necessary to demonstrate that the DISCs performs adequately in comparison with standardised tests in a group of patients who were capable of assessment using both types of instrument. In this cohort, therefore, patients had relatively high level skills, in that they were also all able to complete the BDI-II and the NGRS, and could be categorised by the DSM-IV. Nevertheless, the study presents preliminary evidence for the validity, reliability, and responsiveness of the DISCs in comparison with other standardised measures tested for the assessment of depression in patients with acquired brain injury. In this series, its performance was similar to that of a more conventional design of visual analogue scale, the NGRS—although, rated on a scale of 0–5 instead of 0–10, it may be expected to be somewhat less sensitive.

The high level of agreement between the DSM-IV and the BDI-II in this analysis is not surprising as they cover very similar ground and were usually assessed at the same interview. Although the Yale question showed a reasonably strong association with these scales, it was not as closely related in this study as in some other reported series,^{12, 29} and this raises a small note of caution against the use of this single question approach as a sole screening technique for identifying people with depression in this group.

As highlighted earlier, one of the major challenges to the assessment of depression in this context is the degree of overlap between symptoms of depression and the brain injury itself, and also the differing perceptions of what is meant by the complex notion of “depression” for different individuals. Even the Yale question is not as simple as it sounds—it contains two questions “Do you feel sad?” and “Do you feel depressed?”, and the answers may not necessarily be the same. For example, a patient may feel sad that they have suffered a stroke with its associated losses, but not necessarily depressed. The DISCs and the NGRS used here are based similarly on these combined constructs. Although they attempt to record the patient’s own perception of their level of sadness or depression, they do not provide further insight into what they mean by this, nor the impact of their symptom experience. It is therefore important to follow up these simple questions by more detailed inquiry or investigation,³⁰ particularly where treatment for depression is being considered.

For those patients who are unable to respond verbally, scales which record behaviour suggestive of depression have been developed and may give further insight into the individual’s mood and its impact on their daily activities. Such scales include the Stroke Aphasia Depression Questionnaire (SADQ) in its various forms²⁶ and the Signs of Depression Scale (SDSS).³¹ These scales are still undergoing evaluation, however, and a comparison between the

DISCs, the BDI-II, and the SADQ-H in a related study group is being prepared separately for publication.

There are various limitations to this study. First, the study was undertaken in the context of routine clinical practice as part of a care pathway, as opposed to a specific research setting. Therefore the tools were administered in the logical sequence of a clinical assessment, as opposed to a randomised order (except for the DISCs and NGRS). This may have introduced an element of bias. Second, although the sample did encompass the full range of the scales, the predominant levels of depression in this sample clustered towards the lower end of all the scales, which were therefore not rigorously tested across the full range. Given the fact that depression in the context of brain injury is often relatively mild in comparison with what typically occurs in mental health settings, this may be considered representative of the real life situation. However, for complete evaluation of the DISCs, further evaluation with purposive sampling will be required to test its performance throughout its full range. Finally, the number of participants was relatively small, especially in the subgroups in which test–retest reliability and responsiveness to change were evaluated. The proportion of cases requiring treatment in this series (39%) was approximately similar to the mean for other series,³ so the reduction in numbers from the main group is not surprising, but this raises the need to undertake an evaluation in a larger series. In view of these limitations, the findings presented must be treated with some caution, and further evaluation will be required.

Conclusions

In this cohort of patients with complex disabilities following acquired brain injury, the DISCs showed acceptable convergent validity as a screening tool for depression. A score of ≥ 2 on the DISCs predicted “cases” for depression according to the DSM-IV criteria with greater accuracy than the Yale question. In addition, the DISCs offers the potential advantage of graded assessment, and data from a small subgroup provided preliminary evidence for its responsiveness to change following treatment. Further evaluation is now warranted in the more severely impaired group for which it was originally intended—that is, the group who are unable to respond to more detailed verbal and visual assessments.

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Competing interests: We are unaware of any competing interest other than our desire to disseminate this original scale, which is not being published for financial gain.

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