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Comments on the Spinal Cord Ability Ruler

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We have read with interest the paper by Reed R. et al. [1] proposing the new SCAR scale, one of several tools based on the Spinal Cord Independence Measure (SCIM) [2]. Rasch analysis of SCAR showed unidimensionality of the entire scale, whereas for SCIM III unidimensionality was demonstrated only for its subscales [2]. In our opinion, however, this psychometric advantage is mainly cosmetic, and limits the value of the scale for meaningful clinical practice and research, as detailed below.

1. SCAR is not truly unidimensional, because the gradient within the various SCAR items spans from MRC grading for limb muscles to scores of independence, which is a subtle form of multidimensionality. The multidimensionality of SCAR is nested within item grading, rather than across items. This multidimensionality can be remarkable when lesion level is asymmetric, when significant sensory deficit, ataxia, or spasticity is involved, or when a given functional task is achieved through adaptive "trick" movements. Force and function are frequently non-linearly related, and are not additive. Study of category-fit indices, which are not presented in the SCAR paper, could detect this error. Absolute unidimensionality is unattainable, and the unidimensionality of SCAR can be considered inferior to that demonstrated within the subscales of SCIM III [2], because the total score calculated by the summation of SCIM subscales may be clinically more informative than that of the unidimensional, but diluted, SCAR scale.

2. SCAR is a diluted scale because certain selected SCIM items were removed from it, to reduce multidimensionality. Among the removed items are those supposed to represent "autonomically influenced" involuntary behaviors, but are in reality, fundamental voluntary daily tasks involved in the management of the bladder, bowel, or respiration, and a core target for treatment effect in clinical trials. Changing the items may affect the meaning of the measure, when the items do not continue to reflect entirely the same latent cause [3], and SCAR, therefore, may not be suitable for assessing what SCIM III assesses.

3. Collapsing adjacent categories when creating SCAR, to improve the monotonicity of the thresholds between lower and higher scoring categories, may switch off the error signal, rather than improve assessment. For example, in mobility indoors, collapsing the scores 2 and 3 eliminated the distinction between being wheel-chair bound and walking with supervision. This elimination is particularly improper, as Fig 3a shows that score 2 was rarely assigned, probably an incidental finding, which does not represent the frequency of SCI patients moving independently in manual wheelchairs.

4. The fact that differential item functioning (DIF) was not found for SCAR across some criteria does not indicate that SCAR total score is constructed similarly in different classes of respondents, because: (a) not rejecting the null hypothesis does not demonstrate that it is true; (b) the Bonferroni adjustment that the authors used allows too large a probability of false-negative findings (a less restrictive adjustment, such as the Benjamini–Hochberg false discovery rate method, would be more appropriate) [4]; (c) DIF was not tested across time since lesion; and (d) the analysis did not include differential test functioning, which was widely adopted in the SCIM literature, and could be revealed by unexpected average item difficulty.

5. SCAR lacks the weighting of the raw item grades that is included in SCIM, which reflects an experience-based value judgment.

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6. Unlike SCIM, SCAR measures only independence, and not achievements that are consistent with patient interest. Although the paper mistakenly reflects the notion that SCIM also measures only independence, or the burden of care, SCIM uses the burden of care only as one of the criteria that grade the value of specific patterns of task execution. For example, SCIM scores bladder management using intermittent catheterization higher than using an indwelling catheter, despite the more extensive burden of care it may require.

7. The exclusion of patients with a central cord syndrome allows using SCAR only for certain SCI patients, unlike SCIM, which is suitable for the assessment of all SCI patients.

8. The SCAR model was built by an a posteriori restyling, which can easily lead to cosmetic Rasch improvement. Validation of the suggested model would require a prospective study, or at least leaving out the data of some model-validating centers and replicating the data-model fit obtained from the other model-building centers, for the left-out centers, or alternatively, using the leave-one-out by centers method [5].

9. The SCAR paper does not fully report the Rasch results. The table leaves a lot to be desired: does SEM refer to the mean as noted? Why only $165 + 294$ subjects from the SCAR study and only $46 + 110$ from the SCIM study? Was this taken into consideration in the power analysis?

In summary, may we suggest that SCAR, as presented, can be suitable only for limited research purposes, and it requires further study before it can be used.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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