Determining the Interrater Reliability of the SOFMER Activity Score (version 2) for Individuals in Rehabilitation Centers

Lorraine Charvolin, Pascal Rippert, Sylvain Roche, Muriel Rabilloud, Marie-Doriane Morard, Julie Di Marco, Mickael Dinomais, Margaux Pouyfaucon, Rémi Gimat, Dominique Perennou, et al.

Version of Record: https://www.sciencedirect.com/science/article/pii/S0003999321016336
Manuscript_0635021b82a1a550c33ae0fecf552699

Determining the inter-rater reliability of the SOFMER Activity Score (version 2) for subjects in rehabilitation centers

(Running head: *Inter-rater reliability of SOFMER Score*)

Lorraine Charvolin [1], Pascal Rippert [2], Sylvain Roche [3], Muriel Rabilloud [3], Marie-Doriane Morard [1], Julie Di Marco [4], Mickael Dinomais [5], Margaux Pouyfaucon [6], Rémi Gimat [7], Dominique Perennou [7], Laetitia Houx [8], Jean Iwaz [3], Gilles Rode [4 9], Carole Vuillerot [10]

[1] Service de Médecine Physique et de Réadaptation Pédiatrique (L'Escale), Hôpital Femme–Mère–Enfant, Hospices Civils de Lyon, Bron, France.

[2] Service Recherche et Épidémiologie Clinique, Pôle santé publique, Hospices Civils de Lyon, Lyon, France.

[3] Université de Lyon, Lyon, France; Université Lyon 1, Villeurbanne, France; Hospices Civils de Lyon, Pôle Santé Publique, Service de Biostatistique-Bioinformatique, Lyon, France; CNRS, UMR 5558, Laboratoire de Biométrie et Biologie Évolutive, Équipe Biostatistique-Santé, Villeurbanne, France.

[4] Service de Médecine Physique et Réadaptation, Hôpital Henry-Gabrielle, Hospices Civils de Lyon, Saint-Genis-Laval, France.

[5] Département de Médecine Physique et Rééducation, Centre Hospitalier Universitaire, Angers, France.

[6] Service Médecine Physique et Rééducation Fonctionnelle, Centre Hospitalier Universitaire d'Angers, Angers, France; Centre de Rééducation et de Réadaptation Fonctionnelles Les Capucins, Angers, France; Service de Rééducation, Centre Hospitaliser de Cholet, Cholet, France.

[7] Service Rééducation Neurologique, Hôpital Sud Centre Hospitalier Universitaire de Grenoble-Alpes, Echirolles, France; Laboratoire de Psychologie et Neurocognition (LPNC), Université Grenoble-Alpes, Grenoble, France.

[8] Service de Médecine Physique et de Réadaptation, Centre Hospitalier Régional et Universitaire de Brest, Brest, France; Inserm UMR 1101, Laboratoire de Traitement de l'Information Médicale (LaTIM), Brest, France; Service de Médecine Physique et de Réadaptation Pédiatrique, Fondation Ildys, Brest. France.

[9] Integrative, Multisensory, Perception, Action and Cognition Team (IMPACT), Centre de Recherche en Neurosciences de Lyon (Inserm UMR-S, 1028, CNRS UMR 5292, Université Lyon 1, Université Saint-Etienne), Bron, France.

[10] Service de Médecine Physique et de Réadaptation Pédiatrique (L'Escale), Hôpital Femme–Mère–Enfant, Hospices Civils de Lyon, Bron, France; Institut Neuromyogène, CNRS UMR 5310 – INSERM U1217, Université de Lyon, Lyon, France.

ACKNOWLEDGEMENT

The authors are indebted to late Pr Pierre Alain JOSEPH for having initiated the SOFMER Activity Score project and for his passionate guidance and constant support through the further steps of construction, scoring, and validation of this Score.

DISCLOSURE OF INTEREST

The authors declare that they have no competing interests.

Corresponding author

Dr Lorraine Charvolin

Service central de rééducation,

Hôpital Femme–Mère–Enfant, L'Escale

F-69500, Bron, France.

E-mail: Lorraine.charvolin@gmail.com

Determining the inter-rater reliability of the SOFMER Activity Score (version 2) for subjects in rehabilitation centers

Inter-rater reliability of SOFMER Score

Abstract word count: 243

Text word count: 3909

Number of tables and figures: 5

Number of references: 28

ABSTRACT

***Objectives*:** To assess the inter-rater reliability of the SOFMER Activity Score (SAS, version 2, an 8-item –4 motor and 4 cognitive– and 5-level scale) and improve its scoring system before conducting further validation steps.

Design: Cross-sectional, prospective, observational, non-interventional, and multicentric study.

Setting: The study was conducted between November 2018 and September 2019 in four French rehabilitation centers (two public university hospitals for adults and two private not-for-profit rehabilitation centers for children).

***Participants*:** The study included 101 subjects (mean age: 44.5 years; SD: 25.4; 28.7% under 18 and 18.8% over 65). The female/male sex ratio was 0.6. The causes for admission to the center were mainly neurological (65%) or orthopedic (24%).

Interventions: None.

Main outcome measure: Activity limitation was rated with the SOFMER Activity Score the same day by two independent multidisciplinary teams. The inter-rater reliabilities of the Score items were assessed using weighted kappa coefficients.

***Results*:** All weighted kappa coefficients ranged between 0.83 and 0.92 indicating 'good' to 'excellent' inter-rater reliability. Inter-team score disagreements occurred in 227 scores out of 808 (28%). The reason for most disagreements was unnoticed human or material aid during the observation period.

Conclusion: The results demonstrate the high inter-rater reliability of the SASv2 and allow carrying out further validation steps after minor changes to item scoring instructions and clearer definitions of some items that help improving scoring standardization. The SASv2 may then become a consistent measure of activity level for clinical research or burden of care investigations.

KEYWORDS

Activities of daily living, Rehabilitation, Rehabilitation centers, Reproducibility of results, inter-rater reliability, SOFEMER Activity Score, Chronic limitation of activity

ABBREVIATIONS

FIM: Functional Independence Measure

HCP: health care provider

ICF: International Classification of Functioning, Disability, and Health

IRR: inter-rater reliability

RCs: Rehabilitation Centers

SAS: SOFEMER Activity Score

SASv2: SAS version 2

INTRODUCTION

In May 2001, the International Classification of Functioning, Disability, and Health (ICF) "was officially endorsed by all 191 WHO Member States … as the international standard to describe and measure health and disability" [1]. In the ICF, disability (the antithesis of functioning) refers to impairments of body structures and functions, limitations of activities, and restrictions in participation (activities being tasks or actions an individual performs and participation being the involvement in life situations). Functioning is further qualified by distinguishing between capacity (what persons can do in a standard environment –test conditions) and performance (what persons actually do in their usual environment – community, home).

The ICF approach to disability integrated medical and social aspects into a 'bio-psycho-social' model (including personal and environmental factors) and used new terms to describe disability such as 'impairments', 'limitations in activities', and 'restrictions in participation' [2]. The ICF identifies the necessary components of functioning, but does not provide a measure to quantify functioning.

In rehabilitation medicine, frequent assessments of activity level in subjects with disabilities are essential to anticipate activity loss, support personalized life projects, and make clinical and management decisions. Among the current scales that assess subjects' activities, some are activity-specific (the Functional Ambulation Category [3] or gait speed tests that evaluate the gait but do not reflect overall activity levels) or population-specific (the modified Rankin Scale for post-stroke neurological assessment [4] or the Instrumental Activities of Daily Living adapted to geriatric patients [5]). Another scale is Barthel Index used for "measuring changes in physical function of geriatric rehabilitation patients" [6, 7, 8] or assessing functional recovery after hip fracture [9] or a neurological disorder such as stroke [10]. In contrast, the Functional Independence Measure (FIM) is a general-purpose scale with

74 excellent psychometric properties [11] but is difficult to use in routine hospital care because
75 its administration requires 30 to 45 minutes [12].
76 Given these difficulties, the SOFMER Activity Score (SAS) was adapted from the ICF
77 in 2015 to assess accurately and rapidly the activity levels of subjects admitted to RCs
78 whatever their ages or clinical conditions. The SAS assigns independent scores to selected
79 motor and cognitive aspects of a subject's activity. Thus, though based on the concepts of the
80 ICF, the SAS is shorter and focuses on activity limitation in standardized environments,
81 whereas the ICF describes participation restriction in various individual and environmental
82 conditions.
83 An assessment scale has to undergo several tests to determine its strengths,
84 weaknesses, validity, responsiveness, and reliability [13]. The content validity of the SAS
85 version 1 (i.e., the relevance of its items to essential domains in medical rehabilitation) was
86 already established through three rounds of Delphi method [14] and its feasibility
87 demonstrated in a pilot study that involved 81 subjects. The latter assessment led to SAS
88 version 2 (SASv2) [14]. The validation process is ongoing.
89 In the process of a scale validation, 'reliability' is the reproducibility of the scale's
90 result over successive assessments, assuming the subject's condition has remained constant.
91 Reliability may take two forms: i) test-retest reliability, the reproducibility obtained by the
92 same investigator; and, ii) inter-rater reliability (IRR), the reproducibility obtained by
93 independent investigators assessing the same subject within a short period of time. The latter
94 form is essential because a high IRR is required for a confident use of the scale by various
95 health care providers (HCPs).
96 The aim of this study was to assess the IRR of the SASv2 in adult and pediatric
97 subjects in RCs and improve its scoring system, if necessary, before conducting further
98 validation steps.

METHODS

The SOFMER Activity Score, version 2

The SAS includes two domains: a Motor domain with items 'Hygiene and dressing', 'Feeding', 'Mobility', and 'Elimination'; and a Cognitive domain with items 'Communication', 'Relationships with others', 'Memory and knowledge translation', and 'Task Execution'. Each item may be scored between 1 (the lowest score) and 5. A score of 1 represents 'Activity impossible regardless of help', a 2 'Activity possible with continuous human help', a 3 'Activity possible with human help or supervision', a 4 'Activity possible with technical help and/or adjustment but without human help', and a 5 'Activity possible without help'. The SAS provides instructions with examples to clarify the scoring process.

Study design, setting, and participants

The study was cross-sectional, prospective, observational, non-interventional, and multicentric. Its objective was to determine the IRR of the SASv2 using '**Observer reported outcome' (ObsRO)** assessments [15].

The recruitment took place between November 2018 and September 2019. To be eligible, all subjects had to be aged two years or more, to have been hospitalized for more than four days in any of four French RCs (two public university hospitals for adults and two private not-for-profit RCs for children), and to be able to give informed consent (personally or via authorized persons). There were no exclusion criteria beyond those mentioned above.

All participants were solicited and enrolled by a physician during a stay at RC. They were orally informed about the aim and the process of the study and hand-delivered an information booklet. After consent, the physician collected the following data: age, sex, date, and reason for RC admission.

Study conduct and data collection

To assess the IRR of the SASv2, each subject was scored on all eight items, the same day, by two independent rater teams. The raters had to be HCPs from distinct professions (physician, registered nurse, assistant nurse, therapist, etc.). The number of raters per subject and per team had to be 2, 3, or 4 according to the availability of suitable raters.

The scoring process included no tests and no interviews; it was solely based on the observation of subjects' abilities to perform everyday activities. The eight scores were assigned according to what each subject was seen able to achieve during an at least four-day stay in the RC. A single scoring form was filled out by each rating team; this required, on average, 4.5 minutes per patient and was carried out as a team report during multidisciplinary rounds. The dates and SASv2 scores were recorded together with the professions of the raters. The rater teams were instructed not to communicate with each other until completion of data collection.

The IRR analysis considered thus two series of SASv2 scores (one score per item, per subject, and per rating team) and assessed the reliability between the two rater teams (not between raters of same team).

Statistical analyses

According to the COSMIN Risk of Bias Checklist [16], a 'very good' assessment of the SASv2 reliability requires a sample size greater than 100 subjects.

Each SASv2 item being ordinal with five levels, the IRR of each item was estimated using a weighted kappa coefficient (κ_w) with its 95% confidence interval. This allows expressing reliability as a number between 0 and 1 (0: no reliability; 1: perfect reliability). Fleiss-Cohen weighting scheme (quadratic weights) was used to weight the disagreements [17]. The results were interpreted as suggested by Landis & Koch [18]. Thus, $\kappa_w \geq 0.81$

indicated almost perfect agreement, $0.61 \leq \kappa_w \leq 0.80$ substantial agreement, $0.41 \leq \kappa_w \leq 0.60$ moderate agreement, $0.21 \leq \kappa_w \leq 0.40$ fair agreement, and $\kappa_w \leq 0.20$ slight agreement.

The observed frequencies and percentages of agreements or disagreements between rater teams were examined once, for all eight items, in a single session. Exact and partial agreements on each item were displayed on a Bangdiwala Chart [19] (Figure 1). This chart is a representation that displays concordance in paired categorical data where areas of various color densities represent exact and partial agreements. The Bangdiwala chart reflects also a 'joint distribution of the scores'; i.e., it gives a visual idea about the relative distributions of the scores between the two rating teams.

The analysis examined also the distributions of the scores and floor or ceiling effects. The latter terms are used when the scores are at or near the lower or upper limit, respectively [20]. Herein, floor and ceiling effects relate to inflations of score 1 and score 5, respectively.

All statistical analyses were carried out with Statistical Analysis System software, version 9.4. All tests were two-tailed and $p < 0.05$ was considered for statistical significance.

Ethical considerations

In accordance with the applicable regulations at the time of the study, a purely observational study that did not change the management of the subjects/patients or required their active participation needed neither a formal signed informed consent nor the agreement of an ethical committee. Nevertheless, i) the investigators obtained verbal consents to the collection, analysis, and publication of the study data; and, ii) the study received a favorable opinion from the relevant ethics committee (Comité de Protection des Personnes Sud-Ouest et Outre-Mer IV) on August 31, 2017. According to the current European guidelines (EU General Data Protection Regulation), subjects' data for this research project were anonymized before

analysis and all data that could lead to participants' identification were kept confidential and securely stored.

RESULTS

Participants and raters

Among 109 subjects originally included in all four RCs over eleven months, eight had to be excluded because of one non-compliant rater team. No subjects were excluded after being initially included. Thus, the study kept for analysis data on 101 subjects in whom the eight SASv2 items were scored once by each rating team. As there were no missing scores, 808 data points were provided by each team and 808 pairs of scores could be compared.

The characteristics of the participants are displayed in Table 1. The mean (± SD) age was 44.5 (± 25.4) years; 28.7% of the participants were under 18 and 18.8% over 70. The female/male sex ratio was 60.3%. The participants were mainly admitted to RC for neurological or orthopedic reasons (60.4 and 25.7%, respectively).

The raters of each team were for the most part nurses or assistant nurses. The profession and number of the other raters depended on their availability at the time of scoring. More precisely, the number of raters was 240 in Rating team 1 and 228 in Rating team 2. The HCP occupations (numbers) in Rating teams 1 and 2 were respectively: nurses (105 and 100), assistant nurses (93 and 89), pediatric nurses (21 and 21), rehabilitation physicians (10 and 10), physiotherapist (10 and 1), and medical students (1 and 7).

Distribution of subjects' levels of activity on the SASv2

Figure 1 shows that the distribution of the levels of activity varied widely across items. Level 5 was the most frequent except for items 'Hygiene and dressing' and 'Mobility'. Level 4 was the least frequent especially for items 'Hygiene and dressing' and 'Elimination'. Level 1 was poorly used for items 'Communication' and 'Relationships with others' and Level 2 poorly used for item 'Memory'.

The score distributions varied widely by age group. The ceiling effect was less important in subjects under 18 than in other age groups. Some levels were not represented in the 19 subjects aged >70. Nearly all scores (Level 1 to Level 5) were assigned to each item. No clear floor or ceiling effects were found; only domains 'Feeding', 'Communication', and 'Memory' showed trends toward a ceiling effect (See Figures S1 and S2 in Supplementary Material).

Inter-rater reliability

The percentage of disagreements between the two rating teams was 32.7% for 'Hygiene and dressing', 23.8% for 'Feeding', 39.6% for 'Mobility', 27.7% for 'Elimination', 19.8% for 'Communication', 27.7% for 'Relationships with others', 17.8% for 'Memory', and 34.7% for 'Task execution'.

The weighted kappa coefficients ranged from 0.83 to 0.92 (Figure 2). The lower values concerned items 'Relationships with others' and 'Task execution' of the cognitive domain ($\kappa_w = 0.83$) and item 'Mobility' of the motor domain ($\kappa_w = 0.84$). The less accurate estimations (i.e., widest 95% CIs) concerned items 'Task execution', 'Communication', and 'Relationships with others' (0.13, 0.15, 0.16, respectively, vs. 0.09 to 0.12 for the other items).

Three out of four score disagreements (76.5%) were one-point differences (Tables 2 and 3). Of the 55 disagreements by more than one point, none reached a 4-point difference, only 1 reached a 3-point difference (disagreement between Level 2 and 5). All others were 2-point differences of which 65% were between Levels 3 and 5 (mainly concerning 'Task execution' and 'Relationships with others'), and 22% between Levels 1 and 3.

Score disagreements were the most frequent between Levels 2 and 3 for the motor domain (mainly concerning 'Hygiene and dressing') and Levels 3 or 4 and 5 for the cognitive

domain (mainly concerning ‘Task execution’ and ‘Relationships with others’) (Tables 2 and 3).

Disagreements and consensus scores

After κ_w calculations, the rating teams compared their scores to determine the origins of any disagreements and try to assign consensus scores.

On the 808 pairs of rates, there were 227 (28.1%) disagreements. No reason for disagreement was found for 44 discordant score pairs (44/227; 19.4%), whereas a consensus score could be assigned in 183 discordant score pairs (183/227; 80.6%).

In assigning the consensus scores, the lowest of the two scores was retained from 117 score pairs (117/183; 64%), the highest from 55 pairs (55/183; 30%), and an intermediate whole number score in the remaining 11 pairs (11/183; 6%).

DISCUSSION

The present study reports on the IRR of the SOFMER Activity Score (SAS), a scale that determines the activity level of subjects during medical rehabilitation in RCs. The IRR of any measure of such status is important to ensure data consistency, which allows dependable results and direct comparisons. Here, the weighted Kappa coefficients of agreement used to compare two series of measurements made by two distinct rating teams in subjects with various physical and/or mental impairments were "good" to "excellent", ranging between κ_w 0.83 and 0.92.

As in the pilot study on the SAS [14], nearly all scores (Level 1 to Level 5) were used for each item. Nevertheless, Level 4 was more frequently used than in the pilot study, especially in the cognitive domain. Also, the absence of floor effect is important because it allows assessing activity level improvements over time in the most severely impaired subjects.

A future concurrent validity study is needed to determine whether the current SASv2 levels distinguish activity levels as well as the FIM, which is considered by some to be the 'gold standard' for measuring function [21, 22] and is the most frequently used in French and Swiss RCs. The FIM and the SASv2 were both developed from the ICF [1] (actually, the FIM was developed from the old ICIDH –International Classification of Impairments, Disabilities, and Handicaps). The current results confirm that the SASv2 is as reliable as the FIM [23]. This is supported by 'almost perfect agreements' [18] in item score comparisons between the rating teams; all Kappa coefficients ranged from 0.83 to 0.92. According to Fleiss and Cohen [17], when the scores are ordinal, Kappa coefficients can be interpreted as Intraclass Correlation Coefficients (ICCs); thus, the SASv2 'Memory' domain has a 'very good reliability' ($\kappa_w \geq 0.91$), while the other domains have 'good reliability' (κ_w: 0.71 to 0.90) (0.71 and 0.90 are the ICC boundaries set by Fleiss and Cohen).

One explanation for the very high kappa values is that 76.5% of the disagreements differed by one point only (the κ_w coefficient being weighted by the magnitude of the disagreement between the raters). Another explanation is the effort made to standardize the scoring with accurate definitions of the items and careful instructions on the scale use. For instance, the scale requires a clear distinction between subject's performance and capacity; whereas performance refers to the way a subject copes with disability in real-life situations [24], capacity refers to the level of activity a subject may reach in a standard environment without assistance and represents the HCP's idea of the goals to reach. One advantage of the ICF over the SASv2 is that it explores both concepts; still, the SAS was created to focus on the daily performance of the subjects.

For standardization purposes, the SASv2 instructions underline that a rating team should include HCPs from different professions to ensure a variety of opinions and scores regarding activity limitation [25]. Furthermore, the instructions insist on a four-day observation period. This four-day period has been initially set as: i) the minimum residence time in a RC for subjects inclusion; ii) the time sufficient to allow subject observation in various circumstances by at least two different HCPs; and, iii) the standard time for the successive scale validation steps. This relatively short observation period contributed probably to the high IRRs. It was important that the subjects did not change over the study period, as this would have compromised the testing reliability. Actually, in a previous study [18], observations over longer periods –during which slight or moderate changes in the subjects' clinical conditions occurred– have resulted in less satisfactory IRRs.

The study showed that, in the motor domain, most disagreements concerned Levels 2 and 3 although these levels were not over-represented. The raters related the disagreements to some lack of clarity about the meaning of 'supervision' in the definition of Level 3. Indeed, 'supervision' would suggest the need for assistance with all or part of a given activity. We

suggest thus clarifying the meaning of ‘supervision' in the definitions of Levels 2 and 3 (‘Activity possible with continuous human help or supervision’ and ‘Activity possible with partial human help or supervision’). In the cognitive domain, most disagreements concerned Levels 4 and 5; this might be due to an as yet unexplained over-representation of Level 5. In many cases, the raters’ explanation was the lack of human assistance (e.g., subject ‘unable to cope with night needs’, ‘seeks help’, ‘needs to be stimulated’). This and the fact that the consensus on the final scores were set to lower scores in 65% of all disagreements indicate that a high proportion of scores failed to take into account the subject's whole environment (e.g., use of wheelchair, sit-to-stand lift, or braces or need for human help in transfers or diaper use).

The discussions during the consensus meetings led to better SASv2 standardization. This meant: i) more accurate definitions of ‘Hygiene and dressing’ that excludes now the notion of transfers; ii) clearer examples of SASv2 items that allow for the use of new objects or aspects; e.g., equipment for ‘Elimination’, withdrawal for ‘Relationships with others’, and acting according to one's will for ‘Task execution’; iii) additional and more accurate examples, especially regarding ‘Memory’ and ‘Relationships with others’; and, iv) a suggestion for using a clearer scoring system (See the online Appendix). Indeed, standardized scales have the advantages of controlling for the variety of impairments and disabilities that affect functional assessment, reducing scoring errors, and ensuring effective and consistent scale use various institutions.

As stated above, Kappa coefficients can be interpreted as ICCs [17, 26]. Here, we compare ICCs between various scales, even though IRRs should be compared only between scales with similar aims, domains, items, etc. The mean IRRs of the SASv2 items (all >0.82) compare well with those of the FIM items that ranged between 0.57 and 0.85 with only three of those 18 items having IRRs >0.80 [23]. In addition, a review about Barthel index reported

excellent IRR (0.93) in stroke patients [10] but only low-to-moderate IRRs in the elderly and even worst results in subjects with cognitive impairment [27]. A different review reported that the IRRs of the modified Barthel index ranged between 0.25 and 0.95 [28]. Thus, despite various differences, the SASv2 compares favorably with other known scales. However, as cognitive impairments can decrease functional abilities, it would be interesting to compare motor domain scores between SASv2, Barthel index, and FIM in cognitively intact vs. cognitively impaired subjects.

Assets

One asset of the SASv2 is its immediate, accurate, and reliable use by HCPs. Indeed, using the SASv2 does not require formal training because the scale instructions for use were initially specifically designed and deemed sufficiently clear to be satisfactorily implemented by any HCP. This was proven by the good inter-rater reproducibility seen here. Nevertheless, the successive validation steps may suggest introducing minor amendments for even better implementation.

Additionally, the SASv2 has proven to be less time consuming than other scales. In fact, the raters do not have to scrutinize every aspect of every subject as in other measures in which timed, planned, and targeted observations are required. They do not have to dedicate professional time to those kinds of observations; they just have to state their scores on a subject's activity level after a passive observation of more than four days.

Finally, the FIM has two versions, the FIM (for adults) and the WeeFIM (for children aged six months to seven years), whereas the SASv2 covers children without the need for a separate measure.

Limitations

In this study, the number of raters per team (2 to 4) was significantly lower than in the pilot study (mean: 6.4, range: 2-11) [14]. The explanation is that each RC had to recruit two rating teams; this i) decreased the number of potential raters per team; ii) reduced the benefits from larger teams in terms of observation accuracy; and, iii) increased the risks of errors and omissions. Obviously, the higher the number of raters, the higher the IRR. Thus, we recommend each rating team include at least three HCPs (see online Appendix).

The predominance of nurses and assistant nurses as raters helped obtaining good agreements between raters. Nevertheless, this reflects the reality of the subjects' environment; these HCPs are those who are in frequent daily contact with several subjects within a given RC. The other professionals i) may not have to be in (sufficient) contact with some categories of subjects during their stay (short or irregular care sessions); and, ii) may not be as available as nurses or assistant nurses. This implies seeking, as far as possible, the participation of raters other than nurses.

The IRR is an important early step in the process of scale development. Whether that reliability may differ with subjects' diseases or other factors is certainly an interesting issue but requires other study designs. Another fact of the SASv2 to be considered is the ideal of domain subscores or total score. In principle, the contents of the domains are so varied that a total score might not be relevant in terms of activity level. Nevertheless, potential uses of those scores will be the topics of future studies. Additionally, an analysis may determine whether there is a correlation between the SASv2 total score and the burden of care.

At present, the high IRR of the SASv2 (or its consistency) in RC residents allows evaluating and comparing subjects' activity levels. In the future, it will allow setting health-status improvement objectives, improving management, anticipating activity limitation, and

planning hospital discharge. In addition, accurate measurements of activity levels may reflect the burden of care and help hospital managers improve staffing.

Conclusions

This study succeeded in assessing the IRR of the SASv2 in adult and pediatric subjects admitted to RCs. All IRRs were 0.83 or higher, which indicated 'good' reliability. Discussions on score disagreements improved slightly the previous version of the scale.

In next steps, other important psychometric properties of the SASv2 have to be investigated in multicenter studies: construct validity, criterion validity, convergent validity, test-retest reliability, and responsiveness (or sensitivity to change). These validation steps will provide strong arguments in favor of replacement of other scales that would prove less valid or more time-consuming.

With hopefully successive encouraging results, the SASv2 will prove useful not only for improving and planning care but also for designing clinical trials because the ability to form homogeneous groups of subjects using the SASv2 (or another scale) is essential for testing the efficacy of new drugs or interventions.

REFERENCES

[1] WHO. International Classification of Functioning, Disability and Health (ICF). http://www.who.int/classifications/icf/en.

[2] Stucki G, Cieza A, Melvin J. The International Classification of Functioning, Disability and Health (ICF): a unifying model for the conceptual description of the rehabilitation strategy. J Rehabil Med 2007;39:279-85. https://doi.org/10.2340/16501977-0041.

[3] Holden MK, Gill KM, Magliozzi MR, Nathan J, Piehl-Baker L. Clinical gait assessment in the neurologically impaired. Reliability and meaningfulness. Phys Ther 1984;64:35–40. https://doi.org/10.1093/ptj/64.1.35.

[4] Wilson JTL, Hareendran A, Grant M, Baird T, Schulz UGR, Muir KW, et al. Improving the assessment of outcomes in stroke: use of a structured interview to assign grades on the modified Rankin Scale. Stroke 2002;33:2243–6. https://doi.org/10.1161/01.str.0000027437.22450.bd]

[5] Lawton MP, Brody EM. Assessment of older people: self-maintaining and instrumental activities of daily living. Gerontologist 1969;9:179-86. http://doi.org/10.1093/geront/9.3_Part_1.179

[6] Lam SC, Lee DTF, Yu DSF. Establishing CUTOFF values for the Simplified Barthel Index in elderly adults in residential care homes. J Am Geriatr Soc 2014;62:575–7. https://doi.org/10.1111/jgs.12716.

[7] Bouwstra H, Smit EB, Wattel EM, van der Wouden JC, Hertogh CMPM, Terluin B, et al. Measurement Properties of the Barthel Index in Geriatric Rehabilitation. J Am Med Dir Assoc 2019;20:420-425.e1. https://doi.org/10.1016/j.jamda.2018.09.033.

[8] Smit EB, Bouwstra H, van der Wouden JC, Hertogh CMPM, Wattel EM, Roorda LD, Terwee CB. Development of a Patient-Reported Outcomes Measurement Information System (PROMIS®) short form for measuring physical function in geriatric

rehabilitation patients. Qual Life Res 2020;29:2563-72. https://doi.org/10.1007/s11136-020-02506-5

[9] Mayoral AP, Ibarz E, Gracia L, Mateo J, Herrera A. The use of Barthel index for the assessment of the functional recovery after osteoporotic hip fracture: One year follow-up. PLoS One 2019;14:e0212000. https://doi.org/10.1371/journal.pone.0212000

[10] Duffy L, Gajree S, Langhorne P, Stott DJ, Quinn TJ. Reliability (inter-rater agreement) of the Barthel Index for assessment of stroke survivors: systematic review and meta-analysis. Stroke 2013;44:462–8. https://doi.org/10.1161/STROKEAHA.112.678615.

[11] Dodds TA, Martin DP, Stolov WC, Deyo RA. A validation of the functional independence measurement and its performance among rehabilitation inpatients. Arch Phys Med Rehabil 1993;74:531-6. https://doi.org/10.1016/0003-9993(93)90119-u.

[12] Granger CV, Hamilton BB, Keith RA, Zielezny M, Sherwin FS. Advances in functional assessment for medical rehabilitation. Top Geriatr Rehabil 1986;1:59-74. No doi found.

[13] Health measurement scales: a practical guide to their development and use (5th edition). Aust N Z J Public Health 2016;40:294-5. https://doi.org/10.1111/1753-6405.12484.

[14] Morard MD, Gonzalez-Monge S, Rippert P, Roche S, Bernard JC, Lagauche D, et al. Construction and feasibility study of the SOFMER Activity Score (SAS), a new assessment of physical and cognitive activity. Ann Phys Rehabil Med 2018;61:315-22. https://doi.org/10.1016/j.rehab.2018.04.006.

[15] Walton MK, Powers JH, Hobart J, Patrick DL, Marquis P, Vamvakas S, et al. Clinical Outcome Assessments: Conceptual Foundation–Report of the ISPOR Clinical Outcomes Assessment – Emerging Good Practices for Outcomes Research Task Force DOES THIS HAVE TO BE LABLED AS PART 1. Value Health. 2015;18:741-52. https://doi.org/10.1016/j.jval.2015.08.006.

[16] COSMIN Risk of Bias Checklist. https://www.cosmin.nl/wp-content/uploads/COSMIN-RoB-checklist-V2-0-v17_rev3.pdf

[17] Fleiss JL, Cohen J. The equivalence of weighted kappa and the intraclass correlation coefficient as measures of reliability. Educ Psychol Meas 1973;33:613-9. https://doi.org/10.1177/001316447303300309.

[18] Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics 1977;33:159-74. http://doi.org/10.2307/2529310

[19] Bangdiwala SI, Shankar V. The agreement chart. BMC Med Res Methodol 2013;13:97. https://doi.org/10.1186/1471-2288-13-97.

[20] Everitt BS. The Cambridge dictionary of statistics (2nd ed.). Cambridge, UK: Cambridge University Press. 2002.

[21] Mount Sinai Rehabilitation Center. 2017 Scorecard Inpatient Rehabilitation. https://www.mountsinai.org/files/MSHealth/Assets/HS/Care/Rehab-Medicine/Inpatient-Services/2017Overall-Rehabilitation-Center-Outcomes.pdf

[22] Velozo CA, Byers KL, Wang YC, Joseph BR. Translating measures across the continuum of care: Using Rasch analysis to create a crosswalk between the Functional Independence Measure and the Minimum Data Set Craig A. J Rehab Res Dev 2007;44:467-78. https://doi.org/10.1682/JRRD.2006.06.0068

[23] Ottenbacher KJ, Hsu Y, Granger CV, Fiedler RC. The reliability of the functional independence measure: a quantitative review. Arch Phys Med Rehabil 1996;77:1226-32. https://doi.org/10.1016/s0003-9993(96)90184-7.

[24] Tarvonen-Schröder S, Laimi K, Kauko T, Saltychev M. Concepts of Capacity and Performance in Assessment of Functioning Amongst Stroke Survivors: A Comparison of the Functional Independence Measure and the International Classification of

Functioning, Disability and Health. J Rehabil Med 2015;47. https://doi.org/10.2340/16501977-1974.

[25] Saltychev M, Tarvonen-Schröder S, Bärlund E, Laimi K. Differences between rehabilitation team, rehabilitants, and significant others in opinions on functioning of subacute stroke survivors: Turku ICF study. Int J Rehabil Res 2014;37:229-35. https://doi.org/10.1097/MRR.0000000000000065.

[26] Shrout PE, Fleiss JL. Intraclass correlations: uses in assessing rater reliability. Psychol Bull 1979;86:420-8. https://doi.org/10.1037//0033-2909.86.2.420.

[27] Sainsbury A, Seebass G, Bansal A, Young JB. Reliability of the Barthel Index when used with older people. Age Ageing 2005;34:228–32. https://doi.org/10.1093/ageing/afi063.

[28] Quinn TJ, Dawson J, Walters MR, Lees KR. Reliability of the modified Rankin Scale: a systematic review. Stroke 2009;40:3393–5. https://doi.org/10.1161/STROKEAHA.109.557256.

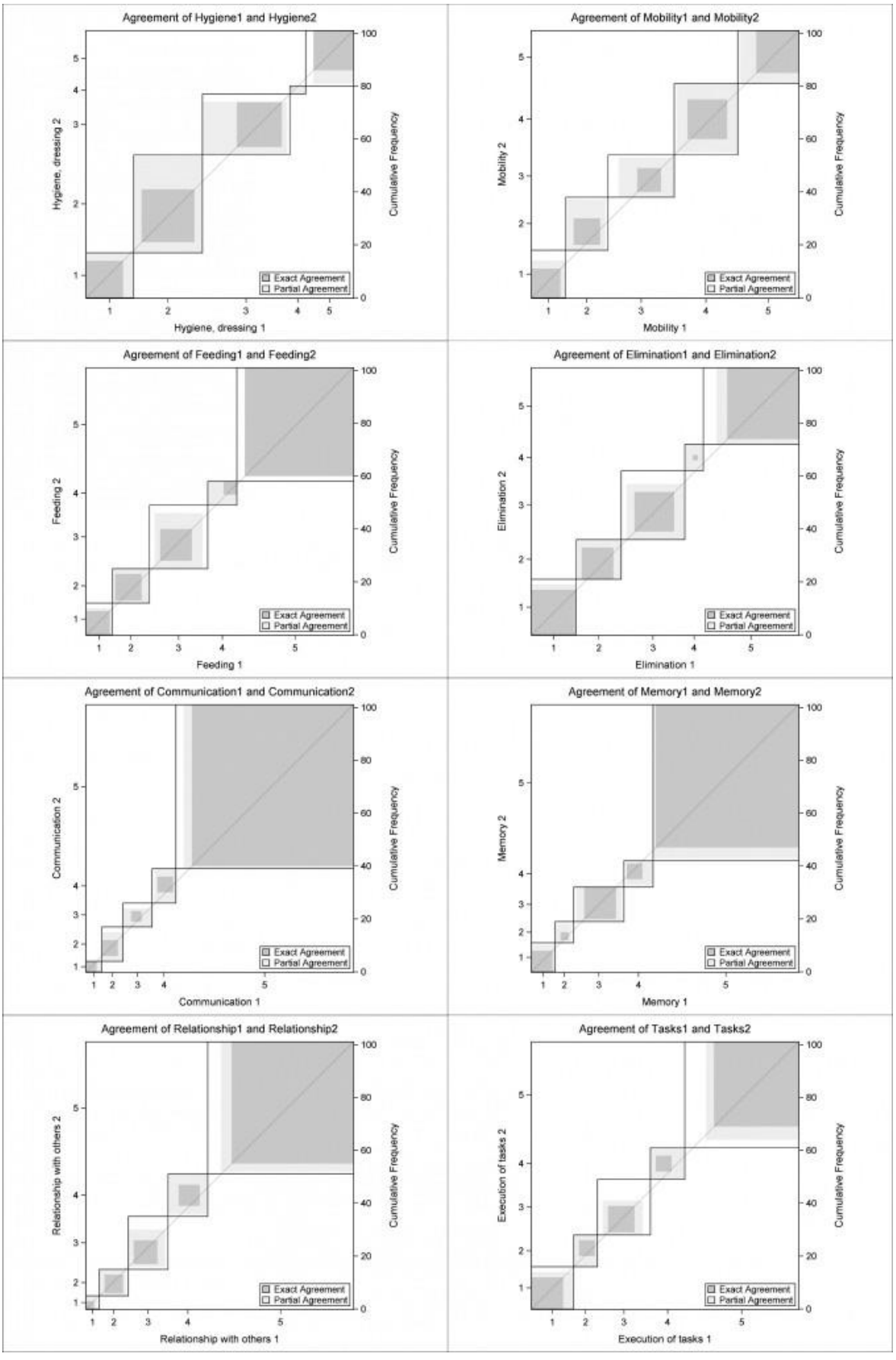
FUNDING

Funding was provided by the *Société française de médecine physique et de réadaptation* (SOFMER) and the French Ministry of Health (Direction générale de l'offre de soins, DGOS) within the context of *Programme de recherche sur la performance du système de soins* (grant no. PREPS-16-390).

LEGENDS TO THE FIGURES

Figure 1 – Bangdiwala's agreement chart comparing SASv2 scores between the two rating teams. Each item is represented in a distinct panel in which the five levels are represented by rectangles with one to three shades of grey. A deep grey area represents an exact agreement, a light grey area a partial agreement with a 'one level away' discrepancy, and a white area a partial agreement with a 'two-level away or more' discrepancy. Mentions "1" and "2" refer to "Rating team 1" and "Rating team 2".

Figure 2 – Weighted kappa coefficients of agreement with their 95% confidence intervals.


Agreement of Hygiene1 and Hygiene2
Hygiene, dressing 2
Hygiene, dressing 1
Cumulative Frequency
Exact Agreement
Partial Agreement
Agreement of Mobility1 and Mobility2
Mobility 2
Mobility 1
Agreement of Feeding1 and Feeding2
Feeding 2
Feeding 1
Agreement of Elimination1 and Elimination2
Elimination 2
Elimination 1
Agreement of Communication1 and Communication2
Communication 2
Communication 1
Agreement of Memory1 and Memory2
Memory 2
Memory 1
Agreement of Relationship1 and Relationship2
Relationship with others 2
Relationship with others 1
Agreement of Tasks1 and Tasks2
Execution of tasks 2
Execution of tasks 1

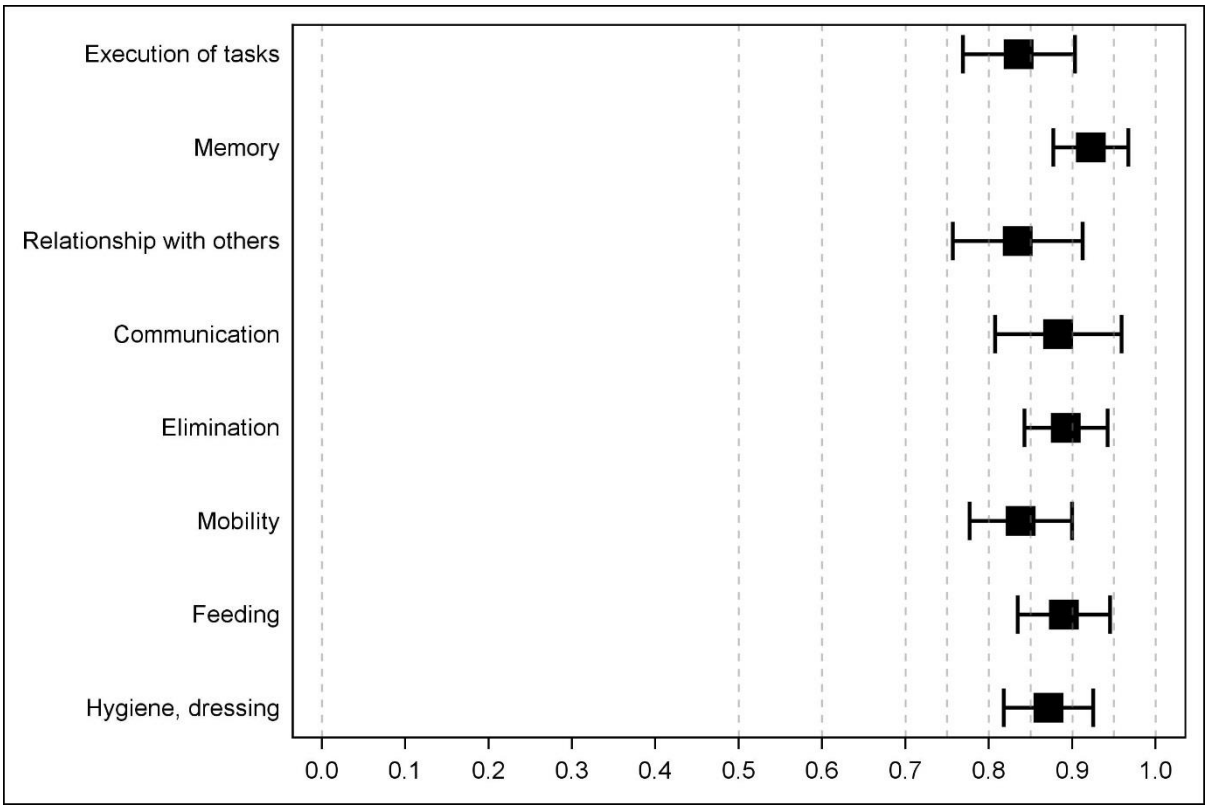

Execution of tasks
Memory
Relationship with others
Communication
Elimination
Mobility
Feeding
Hygiene, dressing
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

Table 1 - Characteristics of the participants in the study of inter-rater reliability of the SOFMER Activity Score (SAS) (n=101)

Characteristic	Number (percentage)
Age category	
<18 years	29 (28.71)
18 – 70 years	53 (52.48)
>70 years	19 (18.81)
Sex	
Females	38 (37.62)
Males	63 (62.38)
Reason for hospital admission	
Neurological of central origin	55 (54.45)
Stroke	23 (22.77)
Cerebral palsy	5 (4.95)
Spinal cord injury	8 (7.92)
Head trauma	6 (5.94)
Degenerative disease	1 (0.99)
Parkinson disease	1 (0.99)
Multiple sclerosis	2 (1.98)
Tumor and malformation	4 (3.96)
Other[1]	5 (4.95)
Neurological of peripheral origin	6 (5.94)
Orthopedic	26 (25.74)
Prosthesis	7 (6.93)
Fracture	6 (5.94)
Traumatic injuries	5 (4.95)
Agenesis	4 (3.96)
Other[2]	4 (3.96)
Cardiopulmonary	2 (1.98)
Rheumatological	2 (1.98)
Bedsore	3 (2.98)
Other causes for hospitalization [3]	5 (4.95)
Unspecified cause for hospitalization	2 (1.98)

[1] Unspecified hemiplegia, hemorrhage, or anoxic cerebral lesion - [2] Osteochondrodysplasia, unspecified intervention, clubfoot, spondylolisthesis - [3] Dissociative amnesia, extreme immaturity, sphingolipidosis, congenital multiple exostoses, Marfan syndrome.

Table 2 – Number of exact and partial agreements regarding the items of the motor domain (101 patients).

Type of agreement	Motor domain items			
	Hygiene, dressing	Feeding	Mobility	Elimination
Exact agreements				
Level 1	14	9	11	17
Level 2	20	10	10	12
Level 3	17	12	9	15
Level 4	1	5	15	2
Level 5	15	41	16	27
Disagreements				
Level 1 vs. 2	7	2	5	2
Level 2 vs. 3	16	5	9	6
Level 3 vs. 4	2	10	9	7
Level 5 vs. 4	5	0	10	6
Level 2 vs. 4	0	0	2	0
Level 3 vs. 1	0	2	4	2
Level 5 vs. 3	4	5	1	5
Level 5 vs. 2	0	0	0	0

Table 3 – Number of exact and partial agreements regarding the items of the cognitive domain (101 patients).

Type of agreement	Cognitive domain items			
	Communication	Relationships	Memory	Task execution
Exact agreement				
Level 1	4	3	8	12
Level 2	6	7	3	6
Level 3	4	9	12	10
Level 4	6	8	6	6
Level 5	61	46	54	32
Disagreement				
Level 1 vs. 2	2	3	3	6
Level 2 vs. 3	5	3	4	3
Level 3 vs. 4	5	7	2	5
Level 5 vs. 4	4	7	5	8
Level 2 vs. 4	1	1	2	0
Level 3 vs. 1	0	1	1	2
Level 5 vs. 3	2	6	1	11
Level 5 vs. 2	1	0	0	0