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ORIGINAL RESEARCH

# Reliability of Spinal Alignment and Range of Motion Measure in children and adolescents with cerebral palsy

*Fidedignidade da Spinal Alignment and Range of Motion Measure em crianças e adolescentes com paralisia cerebral*

*Confiabilidad de Spinal Alignment and Range of Motion Measure para niños y adolescentes con parálisis cerebral*

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**ABSTRACT |** Cerebral palsy is the most frequent cause of physical disability in childhood due to permanent movement and posture development disorders and secondary musculoskeletal problems. The Spinal Alignment and Range of Motion Measure (SAROMM) assess postural deviations and trunk extensibility. This is a cross-sectional study with a convenience sample to evaluate the reliability of SAROMM and to validate its use in clinical practice. In total, 50 children participated in Stage 1 (video evaluation, with and without the instruction manual), and 25 children participated in Stage 2 (in-person evaluation). In Stage 1, the intra-examiner reliability showed almost perfect agreement in all domains (κ ranging from 0.98 to 1.0), except ankle, with a moderate agreement (κ=0.62). Inter-examiner reliability without using the manual showed no agreement (κ ranging from −0.00 to 0.10); with the use of the manual showed weak agreement in all domains (κ from 0.41 to 0.59), except ankle, which showed a minimal agreement (κ=0.20). In Stage 2, inter-examiner reliability showed almost perfect agreement in all domains (κ ranging from 0.93 to 0.97). SAROMM has excellent intra- and inter-examiner reliability, and in-person assessment with the instructions manual is essential.

Keywords | Cerebral Palsy; Reproducibility of Tests; Physiotherapy.

**RESUMO |** A paralisia cerebral é a causa mais frequente de deficiência física na infância devido às desordens permanentes do desenvolvimento do movimento e da postura e aos problemas musculoesqueléticos secundários. Para avaliar desvios posturais e a extensibilidade do tronco, é possível utilizar a *Spinal Alignment and Range of Motion Measure* (SAROMM). Com o objetivo de aferir a fidedignidade da SAROMM e validar seu uso na prática clínica, realizou-se um estudo transversal com amostra de conveniência. Participaram 50 crianças na Etapa 1 (avaliação por vídeo, sem e com o uso do manual de instrução) e 25 crianças na Etapa 2 (avaliação presencial). Na Etapa 1, a confiabilidade intraexaminador apresentou concordância quase perfeita em todos os domínios (κ entre 0,98 e 1,0), exceto tornozelo, que apresentou concordância moderada (κ=0,62). A confiabilidade interexaminadores sem uso do manual não apresentou concordância (κ entre −0,00 e 0,10) e, com uso do manual, concordância fraca em todos os domínios (κ entre 0,41 e 0,59), exceto tornozelo, que apresentou concordância mínima (κ=0,20). Na Etapa 2, a confiabilidade interexaminadores apresentou concordância quase perfeita em todos os domínios (κ entre 0,93 e 0,97). A SAROMM possui excelente confiabilidade intra e interexaminador,

Study conducted at the Graduate Program in Neurosciences of the Ribeirão Preto Medical School, University of São Paulo (FMRP-USP). Data collected at the Rehabilitation Center of HCFMRP-USP and the Integrated Rehabilitation Center of the Hospital Estadual de Ribeirão Preto.

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sendo importante haver uma avaliação presencial com uso do manual de instruções.

Descritores | Paralisia Cerebral; Reprodutibilidade dos Testes; Fisioterapia.

**RESUMEN |** La parálisis cerebral es la causa más frecuente de discapacidad física en la infancia debido a los trastornos permanentes en el desarrollo del movimiento y la postura y a los problemas musculoesqueléticos secundarios. Para evaluar las desviaciones posturales y la extensibilidad del tronco, se puede utilizar *Spinal Alignment and Range of Motion Measure* (SAROMM). Con el fin de evaluar la confiabilidad de SAROMM y validar su uso en la práctica clínica, se realizó un estudio transversal con una muestra de conveniencia. Participaron 50 niños en la Etapa 1 (vídeo evaluación, con y sin uso de la guía instructiva) y 25 niños en la Etapa 2 (evaluación presencial). En la Etapa 1, la confiabilidad intraexaminador mostró concordancia casi total en todos los criterios (κ entre 0,98 y 1,0), excepto tobillo que mostró una concordancia moderada (κ=0,62). La confiabilidad interexaminadores sin uso de la guía no mostró una concordancia (k entre –0,00 y 0,10), con el uso de la guía tuvo una concordancia débil en todos los criterios (κ entre 0,41 y 0,59), excepto tobillo que mostró mínima concordancia (κ=0,20). En la Etapa 2, la confiabilidad interevaluadores mostró una concordancia casi total en todos los criterios (κ entre 0,93 y 0,97). SAROMM tuvo como resultado una excelente confiabilidad intra- e interexaminador, y es importante hacer una evaluación presencial basándose en la guía de instrucciones.

Palabras clave | Parálisis Cerebral; Reproducibilidad de los Resultados; Fisioterapia.

## INTRODUCTION

Cerebral palsy (CP) encompasses a group of permanent disorders in movement and posture development, which causes limitations in activities attributed to non-progressive disorders that occur in fetal development or the infant brain[1], being the main cause of physical disability in children[2].

Recent worldwide population-based studies report the prevalence of CP ranging from 1 to almost 4 per 1,000 live births[3]. The major findings in the last decade regarding early detection, prevention, and treatment have changed the incidence, prognosis, and responsiveness to the treatment of CP[2]. The rate has fallen by 30% in high-income countries such as Australia, reducing CP prevalence to 1.4 per 1,000[4]. Despite prevalence rates being fundamental for the orientation of health policies, the literature lacks studies with specific data on the prevalence and incidence of CP in Brazil[5]. Due to the absence of official records, some studies have been conducted in specific locations, such as Aracajú, where an average prevalence of 1.37 per 1,000 inhabitants was identified. However, in poorer neighborhoods of the municipality, the prevalence was 4 per 1,000[6].

The clinical characteristics of CP—while predominantly involving movement disorders[7]—may be often associated with disorders in sensation, perception, cognition, communication, and behavior, as well as epilepsy and secondary muscle disorders[1]. Musculoskeletal disorders, associated with changes in muscle tone, postural stability, and motor coordination can lead to changes in functional mobility, such as muscle and tendon contractures, joint stiffness, hip displacement, poor biomechanical alignment, and deformities in the spine[1-3], which may lead to decreased range of motion, endurance, and muscle strength[8]. Therefore, the use of instruments is essential to evaluate and monitor changes to body structures and functions, following the International Classification of Functioning, Disability, and Health (ICF)[9].

Schiariti et al.[10] conducted a systematic review to identify the measurement of results in CP using the ICF for Children and Youth. For neuromusculoskeletal and motion-related functions, Gross Motor Function Measure (GMFM), manual function (quality of upper extremity skills test – QUEST), and gait (Gillette Functional Assessment Questionnaire and physician's rating scale – PRS) were used. Notably, none of these instruments specifically assessed postural control, trunk alignment, and muscle amplitude. Thus, it would be essential to develop a tool with this objective, since monitoring these aspects over time is important to determine the required interventions and prevention strategies.

The Spinal Alignment and Range of Motion Measure (SAROMM) was developed as a discriminative tool to be used in rehabilitation and to evaluate the common postural deviations in CP, in addition to the muscular extensibility of regions that make direct connection with the trunk, hip, shoulder, and extremities, such as the ankle[11]. The SAROMM is considered to be a reliable instrument since the intraclass correlation coefficients reflect inter-examiner reliability and test-retest for spine subscales and range of motion, in addition to all the total scores being above 0.80[11].

The SAROMM has four items to evaluate the alignment of the spine and 11 to evaluate the range of motion and capacity of muscle extension, which are tested bilaterally[11]. Each item is scored on a five-point ordinal scale: 0 – there are no alignment limitations with active correction; 1 – good alignment with passive correction; 2 – the limitation is almost completely reduced in passive correction and there is minimal deformity; 3 – the limitation is almost not passively reducible and there is a moderate deformity; 4 – the limitation is not reducible and the deformity is severe in the alignment of the spine or there is a limitation in the range of motion or muscle extensibility[11].

In 2014, Lopes and Pfeifer[12] performed a cross-cultural adaptation for the Brazilian population, and the instrument was called SAROMM-BR. One of the stages of the validation process of a culturally adapted instrument is to verify reliability, which is the ability to consistently reproduce a result in time and space, or with different observers, regarding stability, internal consistency, and equivalence[13]. Thus, this study aims to evaluate the reliability regarding internal consistency and intra- and inter-examiner equivalence of SAROMM-BR to guide its use in clinical practice with children and adolescents with CP at different motor levels.

## METHODOLOGY

This is a cross-sectional methodological study, carried out in two stages, based on a convenience sample.

Children and adolescents with CP, aged 3 to 16 years, of both sexes and with different levels of motor impairment according to the expanded and revised Gross Motor Function Classification System (GMFCS E&R)[14], recruited at the Rehabilitation Center of the Hospital das Clínicas da Faculdade de Medicina de Ribeirão Preto (CER – HCFMRP), at the Integrated Rehabilitation Center of the Hospital Estadual de Ribeirão Preto (CIR – HERP), and at the Physical Therapy Clinic of the Barão de Mauá University Center (CBM) composed the sample of this study. Participants were excluded if they did not understand or did not respond to simple orders; also those who presented associated disorders, such as deafness or blindness, according to the information of the therapists responsible for their rehabilitation care were excluded. The caregivers signed an informed consent form and the children and adolescents verbally agreed to participate.

In Stage 1, conducted in 2015, 50 children and adolescents with CP participated. In Stage 2, conducted in 2019, 25 children and adolescents with CP participated. The participants of the two stages were different ones.

The application of SAROMM lasted an average of 25 minutes for each participant. For the evaluation of items 1 to 4 (alignment of the spine) and 25/26 (upper limbs), the participant was positioned sitting on the table or on a bench, with their posture aligned and positioned with their feet on the ground, with preserved distance, popliteal angle at 90°, without hip flexion greater than 90°, always respecting if the participant presented muscle contracture that kept them above 90° of hip flexion. Regarding items 1 to 4, the evaluator observed whether the participant was able to actively correct the alignment of the cervical, thoracic, and lumbar spine, without presenting a limitation in the alignment of the spine in the frontal and transverse planes. If necessary, the evaluator handled the participant to verify whether the limitation was flexible or fixed (classified as mild, moderate, or severe). To evaluate items 25/26, the evaluator requested to the participant to extend the upper limbs parallel to their ears. If they could not, the evaluator separately manipulated each of the upper limbs and classified whether the limitation was flexible, mild, moderate, or severe, on each side.

To evaluate items 5 to 24 (evaluation of range of motion and muscle extensibility), the participant was positioned in supine position on the table. In this stage, the range of motion was evaluated considering hip extension, flexion, abduction, adduction, external and internal rotation; knee and hamstring extension; and ankle dorsiflexion and plantarflexion. For these items, the evaluator handled each of the lower limbs of the participant separately to verify the limitation and classified it as flexible, mild, moderate, or severe on each side.

In Stage 1, intra- and inter-examiner reliability was performed via observational evaluation and SAROMM scores. The observational evaluations occurred independently and were performed by two physical therapists with experience in Neuropediatrics (Evaluator 1 and Evaluator 2), who scored the aspects listed in the SAROMM by analyzing the videos. Evaluator 1 participated in the cultural adaptation process of SAROMM and already had experience using the scale, while Evaluator 2 had not had contact with SAROMM before this stage of analysis and received a 2-hour video training, which consisted of the presentation of the scale and joint evaluation of two children. After evaluating the entire sample, Evaluator 2 received the training again (evaluation by video), including, this time, reading and clarifying the application manual, followed by a new evaluation of the entire sample, with an interval of at least 30 days between the evaluation without the manual and the evaluation with manual, to avoid memory bias.

Each participant was evaluated individually by Evaluator 1, the procedure was filmed with a fixed camera on a tripod. Evaluator 1 scored the performance of each participant immediately after the evaluation (EV1) and, after 30 days, again via the videos (EV2), to prevent memory from influencing the scores. Evaluator 2 watched the videos of each participant and scored (EV3) after the first training (without knowledge of the manual) and, after the second training (EV4), with knowledge and use of the manual. Intra-examiner reliability compared EV1 with EV2, and inter-examiner reliability compared EV1 with EV3 (without manual) and EV1 with EV4 (with the manual).

In Stage 2, inter-examiner reliability was performed using in-person evaluation and SAROMM scores. The in-person evaluations occurred independently (with a 2 to 7 days interval) and were performed by two physical therapists with experience in Neuropediatrics (Evaluator 1 and Evaluator 3), who had access to the SAROMM manual. Evaluator 1 participated in the cultural adaptation process of SAROMM and already had experience in the use of the scale, while Evaluator 3 had not had contact with SAROMM before this stage but was trained and had access to the manual for reading and clarification.

The results of the evaluations were organized in Excel spreadsheets and the concordance analyses were performed using the intraclass correlation coefficient (ICC) and Cohen's kappa correlation coefficient, using Stata 15 software. In Stage 1, intra-examiner reliability (EV1×EV2); inter-examiner reliability via video and without the use of the manual (EV1×EV3); and inter-examiner reliability with the observational evaluation via video with the use of the manual (EV1×EV4) were analyzed. In Stage 2, the inter-examiner reliability was analyzed with the use of the instruction manual and with in-person evaluation (Evaluator 1 and Evaluator 3).

For the intra- and inter-examined reliability analyses, the criteria proposed by Landis and Koch[15] were adopted for interpreting the degree of agreement: almost perfect (0.81–1.00); strong (0.61–0.80); moderate (0.41–0.60); regular (0.21–0.40); discrete (0–0.20); and poor (<0).

Internal consistency was analyzed by Cronbach's alpha, obeying the recognized limits between 0.70 and 0.90[16].

## RESULTS

In total, 75 children and adolescents with CP, aged 3 to 16 years, participated in this study. Table 1 shows the categorization of the sample in the two stages of the research (Stage 1 – observational evaluation; and Stage 2 – in-person evaluation).

Table 1. Characteristics of participants at each stage of the research

| Characteristic | Stage 1 | Stage 2 |
|---|---|---|
| Age (average) | 8.5 years | 6 years |
| Sex | | |
| Male | 32 (64%) | 15 (60%) |
| Female | 18 (36%) | 10 (40%) |
| Clinical condition | | |
| Spastic | 40 (80%) | 23 (92%) |
| Ataxic | 2 (4%) | 2 (8%) |
| Dyskinetic | 8 (16%) | 0 |
| Topography | | |
| Unilateral | 10 (20%) | 4 (16%) |
| Bilateral | 40 (80%) | 21 (84%) |
| GMFCS | | |
| I | 8 (16%) | 5 (20%) |
| II | 12 (24%) | 5 (20%) |
| III | 10 (20%) | 5 (20%) |
| IV | 8 (16%) | 5 (20%) |
| V | 12 (24%) | 5 (20%) |
| Observed number | 50 | 25 |

GMFCS: Gross Motor Function Classification System.

The internal consistency of the SAROMM was evaluated by Cronbach's alpha, obtaining satisfactory indices ranging 0.74–0.76.

The agreement analysis was performed using Cohen's kappa correlation coefficient and the results showed an almost perfect agreement index in all domains, except ankle, which presented strong agreement (Table 2).

The inter-examiner analysis was performed, comparing the first evaluation of Evaluator 1 (EV1) with that of Evaluator 2 (EV3), with the analysis of the videos and without using the manual. The agreement analysis was performed using Cohen's kappa correlation coefficient and the results show a discrete and poor agreement index in the domains (Table 3).

Then, the inter-examiner agreement was analyzed in the comparison between EV1 and EV4 (second evaluation of Evaluator 2 with the videos and the manual), using Cohen's kappa correlation coefficient. The results improved, with moderate agreement index in all domains, except the ankle, which presented mild agreement[15] (Table 3).

Table 2. Weighted kappa of intra-examiner analysis

| | Agreement (%) | Expected agreement (%)[a] | Kappa | Standard error | z | Prob>z |
|---|---|---|---|---|---|---|
| Mean spine | 100.00% | 69.40% | 1.0000 | 0.0853 | 11.72 | 0.0000 |
| Mean hip | 99.56% | 69.67% | 0.9853 | 0.0899 | 10.96 | 0.0000 |
| Mean knee | 99.45% | 69.85% | 0.9819 | 0.0869 | 11.30 | 0.0000 |
| Mean ankle | 92.00% | 78.57% | 0.6266 | 0.0779 | 8.04 | 0.0000 |
| Mean upper limb | 100.00% | 63.85% | 1.0000 | 0.0927 | 10.79 | 0.0000 |

[a] The agreement observed is the proportion of cases in which the evaluators agreed with each other, in relation to the total observed; the expected agreement is that which would occur simply by chance. Notably, the expected agreement presented lower rates than those of the agreement obtained.

Table 3. Weighted kappa inter-examiner with and without manual

| | Agreement (%) | Expected agreement (%)[a] | Kappa | Standard error | z | Prob>z |
|---|---|---|---|---|---|---|
| No manual | | | | | | |
| Mean spine | 71.70% | 69.29% | 0.0784 | 0.0868 | 0.90 | 0.1831 |
| Mean hip | 68.75% | 70.44% | −0.0574 | 0.0871 | −0.66 | 0.7448 |
| Mean knee | 74.43% | 71.40% | 0.1060 | 0.0852 | 1.24 | 0.1067 |
| Mean ankle | 79.58% | 79.60% | −0.0009 | 0.0955 | −0.01 | 0.5036 |
| Mean upper limb | 69.79% | 70.47 | −0.0230 | 0.0838 | −0.27 | 0.6082 |
| With manual | | | | | | |
| Mean spine | 87.02% | 70.68% | 0.5573 | 0.0830 | 6.71 | 0.0000 |
| Mean hip | 84.25% | 70.54% | 0.4653 | 0.0797 | 5.84 | 0.0000 |
| Mean knee | 89.26% | 73.65 | 0.5925 | 0.0826 | 7.17 | 0.0000 |
| Mean ankle | 80.00% | 74.88% | 0.2039 | 0.0742 | 2.75 | 0.0030 |
| Mean upper limb | 78.82% | 63.80% | 0.4149 | 0.0799 | 5.19 | 0.0000 |

[a] Notably, the expected agreement presented lower rates than the agreement obtained in the evaluation with the use of the instructions manual.

Thus, Stage 2 sought to verify whether reliability was related to the method of evaluation (by video or in-person). Understanding that the success of a physical evaluation can be influenced by the evaluator's close contact with the child/adolescent, it was also verified the inter-examiner reliability, in which both evaluators assessed personally and independently the same participant (Evaluator 1 and Evaluator 3). The agreement analysis was performed using Cohen's kappa correlation coefficient and the results show a discrete and poor agreement index in the domains (Table 4).

Table 4. Weighted kappa inter-examiners (Stage 2 – in-person)

| | Agreement (%) | Expected agreement (%)[a] | Kappa | Standard error | z | Prob>z |
|---|---|---|---|---|---|---|
| Mean spine | 97.82% | 67.94% | 0.9319 | 0.1225 | 7.61 | 0.0000 |
| Mean hip | 98.91% | 68.25% | 0.9656 | 0.1307 | 7.39 | 0.0000 |
| Mean knee | 98.50% | 67.42% | 0.9540 | 0.1317 | 7.25 | 0.0000 |
| Mean ankle | 99.00% | 73.48% | 0.9623 | 0.1340 | 7.18 | 0.0000 |
| Mean upper limb | 98.86% | 60.14% | 0.9713 | 0.1403 | 6.92 | 0.0000 |

[a] Notably, the expected agreement presented lower rates than those of the agreement obtained.

We verified an improvement in the agreement indices throughout the process and a new analysis was performed using the intraclass correlation coefficient. Table 5 shows the results of all correlations.

Table 5. Intraclass correlation coefficient of intra- and inter-examiner analyses with manual, without manual, and in-person

| | Intra-examiner | | Inter-examiner without manual | | Inter-examiner with manual | | Inter-examiner in-person | |
|---|---|---|---|---|---|---|---|---|
| Characteristic | ICC | Confidence interval 95% | ICC | Confidence interval 95% | ICC | Confidence interval 95% | ICC | Confidence interval 95% |
| Mean spine | 1 | - | 0.877 | 0.781–0.931 | 0.880 | 0.786–0.933 | 0.995 | 0.989–0.997 |
| Mean hip | 0.99 | 0.998–0.999 | 0.901 | 0.823–0.944 | 0.969 | 0.944–0.982 | 0.997 | 0.993–0.998 |
| Mean knee | 0.998 | 0.997–0.999 | 0.890 | 0.804–0.938 | 0.945 | 0.902–0.969 | 0.996 | 0.992–0.998 |
| Mean ankle | 0.987 | 0.978–0.992 | 0.209 | −0.410–0.556 | 0.382 | −0.101–0.653 | 0.990 | 0.979–0.995 |
| Mean upper limb | 1 | - | 0.755 | 0.562–0.862 | 0.762 | 0.575–0.866 | 0.997 | 0.993–0.998 |

ICC: Intraclass Correlation Coefficient

## DISCUSSION

This study showed that SAROMM presents adequate indices of internal consistency and reliability of intra-examiner equivalence. Additionally, we observed that the inter-examiner equivalence reliability was positively influenced by the use of the manual to apply the evaluation and in the understanding of the criteria for classifying the participants' behaviors, as well as by performing the evaluation in-person (with the therapist's handling), and not by video analysis (observational), regardless of the age and motor level of the participant.

Children with CP often have secondary deficiencies in spine alignment, limbs range of motion, endurance for activities, and muscle strength. Thus, SAROMM is a useful tool in the identification of postural changes in children with CP, guiding clinical decision-making[8].

According to Mancini and Horak[17], posture control is required to achieve balance, which can be defined as maintenance, range, and return of the center of mass within the support base. Functional objectives in achieving balance and posture control include maintaining adequate postural alignment and symmetry, which are essential to facilitate voluntary movement, postural transfers and, also, the restoration of balance under the influence of external disorders. Thus, the postural characteristics evaluated by SAROMM are believed to be essential requirements in the maintenance of static and dynamic balance activities and coordination in sitting posture.

The internal consistency of the instrument showed good results since the alpha values indicate recognized limits between 0.70 and 0.90, considering that values below 0.70 indicate non-consistency and values above 0.90 may indicate redundancy of items of the instrument[16]. In the study on the development and preliminary psychometric tests of SAROMM[11], there is no information about internal consistency, which makes it impossible to compare with our results. Although the study by Chen et al.[18] aimed to evaluate the validity, responsiveness, and psychometric properties of SAROMM, internal consistency analysis was not performed.

Few studies have used SAROMM; its use has, nonetheless, expanded in recent years. The cross-cultural adaptation process of the SAROMM was developed in China[18], Brazil[12], and Türkiye[19]. Lima et al.[20] used SAROMM to describe the postural alignment and muscle extensibility of eight children/adolescents with CP, enabling an expanded functional diagnosis of the evaluated cases.

Other studies have sought to verify correlations between variables and musculoskeletal impairment, spine alignment, and range of motion (measured by SAROMM). Wright and Bartlett[21] evaluated 225 adolescents with CP to verify the correlation between functionality and the presence of contractures and deviations in the spine. Chen et al.[22] examined whether some variables, including spine alignment and range of motion, are potential predictors of child development in 78 children with CP, with average age of 3 years and 8 months. McDowell et al.[23] evaluated 123 young people (classified IV and V levels of GMFCS) for quality of life, pain intensity, and musculoskeletal impairment.

Silva et al.[24] evaluated postural alignment and muscle extensibility in children with CP after aquatic physical therapy. Jeffries et al.[8] evaluated 708 children with CP at all levels of GMFCS, aged from 18 months to 12 years, every 6 months over a 2-year period, aiming at creating longitudinal developmental trajectories for range of motion in relation to the motor level. Cominetti, Gerzson, and Almeida[25] evaluated the musculoskeletal alterations, the alignment of the spine, and the range of motion of 28 children and adults institutionalized with CP, with the objective of defining strategies to minimize the progress of past deformities.

The mentioned studies demonstrate the importance of using SAROMM as a diagnostic measure for trunk functioning in children/adolescents with CP, enabling a clinical diagnosis and contributing for the definition of therapeutic objectives. Thus, defining the application procedures is essential for obtaining reliable results. As far as we know, only the original study evaluated the inter-examiner equivalence reliability and test-retest reproducibility with a sample of only 25 participants[11], which justified the performance of this study to evaluate the equivalence of SAROMM (intra- and inter-examiner reliability) and the influence of the manual and the therapist's in-person evaluation to guide its use in clinical practice with children and adolescents with CP, demonstrating the degree of reliability of this instrument.

In Stage 1, intra-examiner reliability obtained high rates of agreement, demonstrating that the instrument is reliable and, despite Evaluator 1 performing the first in-person evaluation and the second by videos, the results presented almost perfect agreement indices, according to Landis and Koch[15].

For the inter-examiner analysis, a previous training of Evaluator 2 was performed with video analysis. This training procedure was also used by Jeffries et al.[8], being considered an effective strategy. In our study, however, the initial inter-examiner agreement indices (without the use of the instruction manual) ranged from discrete to poor, according to Landis and Koch[15]. This allowed us to discuss the need for more intense training and using the scale instruction manual. This second training was similar to that of the study by Chen et al.[18], in which the evaluators were trained by a certified senior physical therapist to administer the SAROMM by carefully reviewing the written instructions and with repeated practice. After this second training and with the use of the manual, the results improved, with moderate agreement index in all domains, except the ankle, which presented regular agreement, according to Landis and Koch[15].

Since there was this great difference between the intra- and inter-examiner agreement indices, the hypothesis was raised that the discrepancy between the evaluators was due to the difference in the mode of evaluation (observational versus in-person). Therefore, we sought to verify whether the evaluation medium (video) used in this stage influenced the results. Localized studies using SAROMM report that the evaluations were made by trained therapists, however, they do not specify whether they occurred via video or in-person, but it is believed that they occurred in-person[8].

Subsequently, in Stage 2, both evaluators assessed the same participants in-person at different times. The results show that inter-examiner agreement was considered almost perfect, with values above 0.98. These values were above those obtained by Barlett and Purdie[11], who conducted the reliability study of the original version of the SAROMM and obtained values between 0.81 and 0.93.

The comparison between the results of Stages 1 and 2 showed the clinical importance of the evaluator to assess the patient in-person, with direct contact. In Stage 1, we noticed a difficulty in evaluating alignments and the discrete movements of internal hip rotation and ankle amplitudes since the video only showed one angle. Although SAROMM was not designed to evaluate in detail ranges of motion and spasticity, different levels of spasticity may influence the scoring of some items[11]. Thus, we believe that the evaluator is not only an observant but is directly active in clinical management; and the spasticity factor, which requires direct contact with the child, is necessary to measure the stiffness found in the patient during the evaluation.

In view of the results, it was found that the evaluation performed in-person presented better results. This leads to reflection on the importance of an in-person physical examination, which allows for the therapist to perceive the evaluation and to physically handle the patient following the procedures proposed in the measurement instrument, combined with his professional skills developed throughout his clinical experience.

This study is limited by its restricted sample due to the variability of clinical condition and possible impairments in CP cases. A wider sample could contemplate greater diversity. The absence of homogeneity of the distribution of participants in the five different motor levels did not allow for the analysis of the influence of motor gravity on inter-examiner reliability.

Moreover, we had a different second evaluator for Stages 1 and 2, which may have generated another variable (the ability of the evaluator), not considered in this study. We recommend for further studies—in verifying the reliability of the Brazilian version of SAROMM—to be conducted by students and professionals in the rehabilitation area (physical therapists and occupational therapists), with different levels of procedural assessment abilities.

## CONCLUSION

SAROMM can be useful as an evaluation method for characterizing the population/subject, defining therapeutic objectives, and as a measure of outcome in Brazilian children/adolescents with CP.

It presents high or almost perfect agreement, but with reliability difference between the evaluation models, being recommended the in-person evaluation instead of the observational by video, due to the influence of the altered muscle tones and reflexes of the evaluated population.

Thus, it is concluded that the adapted Brazilian version of the SAROMM (SAROMM-BR) has excellent intra- and inter-examiner reliability and demonstrates the clinical importance of conducting in-person evaluation of patients based on the instrument manual.

## REFERENCES


1. Rosenbaum P, Paneth N, Leviton A, Goldstein M, Bax M, et al. A report: the definition and classification of cerebral palsy. Dev Med Child Neurol Suppl. 2007;109:8-14.
2. Novak I. Evidence-based diagnosis, health care, and rehabilitation for children with cerebral palsy. J Child Neurol. 2014;29(8):1141-56. doi: 10.1177/0883073814535503.
3. Brasil. Ministério da Saúde. Secretaria de Atenção à Saúde. Departamento de Ações Programáticas Estratégicas. Diretrizes de atenção à pessoa com paralisia cerebral. Brasília (DF): Ministério da Saúde; 2013.
4. Galea C, Mcintyre S, Smithers-Sheedy H, Reid SM, Gibson C, Delacy M, et al. Cerebral palsy trends in Australia (1995-2009): a population-based observational study. Dev Med Child Neurol. 2019;61(2):186-93. doi: 10.1111/dmcn.14011.
5. Felice TMN. Associação dos fatores de risco para paralisia cerebral com os aspectos clínicos e funcionais [dissertation]. Ribeirão Preto: Universidade de São Paulo; 2021.
6. Peixoto MVS, Duque AM, Carvalho S, Gonçalves TP, Novais APS. Características epidemiológicas da paralisia cerebral em crianças e adolescentes em uma capital do nordeste brasileiro. Fisioter Pesqui. 2020;27(4):405-12. doi: 10.1590/1809-2950/20012527042020.
7. Vitrikas K, Dalton H, Breish D. Cerebral palsy: an overview. Am Fam Physician. 2020;101(4):213-20. doi: 10.1007/s12098-017-2475-1.
8. Jeffries LM, Fiss AL, McCoy SW, Bartlett D, Avery L. Developmental trajectories and reference percentiles for range of motion, endurance, and muscle strength of children with cerebral palsy. Phys Ther. 2019;99(3):329-38. doi: 10.1093/ptj/pzy160.
9. OMS. Organização Mundial da Saúde. CIF: Classificação Internacional de Funcionalidade, Incapacidade e Sáude. São Paulo: Edusp; 2003.
10. Schiariti V, Selb M, Cieza A, O'Donnel M. International Classification of Functioning, Disability and Health Core Sets for children and youth with cerebral palsy: a consensus meeting. Dev Med Child Neurol. 2015;57(2):149-58. doi: 10.1111/dmcn.12551.
11. Bartlett D, Purdie B. Testing of the spinal alignment and range of motion measure: a discriminative measure of posture and flexibility for children with cerebral palsy. Dev Med Child Neurol. 2005;47(11):739-43. doi: 10.1017/S0012162205001556.
12. Lopes RR, Pfeifer LI. Adaptação transcultural e estudo preliminar da escala Spinal Alignment and Range of Motion Measure – SAROMM [dissertação]. Ribeirão Preto: Faculdade de Medicina de Ribeirão Preto; 2014.
13. Souza AC, Alexandre NMC, Guirardello EB. Propriedades psicométricas na avaliação de instrumentos: avaliação da confiabilidade e da validade. Epidemiol Serv Saude. 2017;26(3):649-59. doi: 10.5123/S1679-49742017000300022.
14. Silva DBR, Pfeifer LI, Funayama CAR, translators. GMFCS – E & R: sistema de classificação da função motora grossa: ampliado e revisto. Hamilton: McMaster University; 2010 [cited 2022 Dec 2]. Available from: https://canchild.ca/system/tenon/assets/attachments/000/000/075/original/GMFCS-ER_Translation-Portuguese2.pdf
15. Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics. 1977;33(1):159-74.
16. Nunnally JC. Psychometric theory. 2nd ed. New York: McGraw Hill; 1978.
17. Mancini M, Horak FB. The relevance of clinical balance assessment tools to differentiate balance deficits. Eur J Phys Rehabil Med. 2010;46(2):239-48.
18. Chen CL, Wu KP, Liu WY, Cheng HY, Shen IH, Lin KC. Validity and clinimetric properties of the Spinal Alignment and Range of Motion Measure in children with cerebral palsy. Dev Med Child Neurol. 2013;55(8):745-50. doi: 10.1111/dmcn.12153.
19. Arikan Z, Mutlu A, Li̇vanelioğlu A. An evaluation of spinal alignment and musculoskeletal system influence at different functional levels of children with cerebral palsy. Turkish J Physiol Rehabil. 2020;31(2):171-9. doi: 10.21653/tjpr.517950.
20. Lima JLS, Negreiros ASV, Lima AKP. Postural alignment and muscle extensibility assessment's by the SAROMM scale in children and teenagers with cerebral palsy. Res Soc Develop. 2021;10(15):e54101522502. doi: 10.33448/rsd-v10i15.22502.
21. Wright M, Bartlett DJ. Distribution of contractures and spinal malalignments in adolescents with cerebral palsy: observations and influences of function, gender and age. Dev Neurorehabil. 2010;13(1):46-52. doi: 10.3109/17518420903267101.
22. Chen CM, Hsu HC, Chen CL, Chung CY, Chen KH. Predictors for changes in various developmental outcomes of children with cerebral palsy—a longitudinal study. Res Dev Disabil. 2013;34(11):3867-74. doi: 10.1016/j.ridd.2013.08.007.

23. McDowell BC, Duffy C, Lundy C. Pain report and musculoskeletal impairment in young people with severe forms of cerebral palsy: a population-based series. Res Dev Disabil. 2017;60:277-84. doi: 10.1016/j.ridd.2016.10.006.

24. Silva EM, Silva TAS, Balk RS, Lopes RR, Santos CC, et al. Avaliação do alinhamento postural e extensibilidade muscular pela escala SAROMM em crianças com paralisia cerebral após fisioterapia aquática. Fisioter Bras. 2017;18(6):719-26. doi: 10.33233/fb.v18i6.2054.

25. Cominetti EPA, Gerzson LR, Almeida CS. Aplicação da escala Spinal Alignment and Range of Motion Measure (SAROMM) em crianças e adultos com paralisia cerebral, em uma instituição de abrigagem de Porto Alegre (RS). Fisioter Pesqui. 2020:27(3):277-86. doi: 10.1590/1809-2950/19024427032020.