ORIGINAL ARTICLE

# Psychometric Properties of Persian Version of Child Sensory Profile-2 in Children with Cerebral Palsy

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## ABSTRACT

**Objectives:** The focus on children with cerebral palsy (CP) has mostly been on its postural, balance, and movement constraints. However, another factor that affects children's daily functioning the manifestation of sensory processing irregularities and disorders. A standard tool can provide in-depth insight into sensory processing in children with CP by appropriately addressing their sensory issues.

**Materials & methods:** In this cross-sectional study, 143 children with CP participated to measure the reliability and validity of the Persian version of the Child Sensory Profile-2 (CSP-2) in children with CP. Data were collected using the Persian version of CSP-2 (parent/caregiver form) and analyzed using SPSS-26 software.

**Results:** The current study revealed that Persian version of CSP-2 has good divergent validity in children with CP ($p<0.001$) as children with CP showed significantly different sensory processing patterns compared to typically developing peers, with higher scores across most subscales including Sensitivity ($r = –0.61$), Avoiding ($r = –0.33$), Registration ($r = –0.21$), and Seeking ($r = –0.42$). Excellent internal consistency showed that all items are internally consistent and reliable ($0.78\leq\alpha\leq 0.91$). The Intraclass Correlation Coefficient (ICC) that was used to measure test-retest reliability also confirmed its test-retest reliability ($0.84\leq ICC\leq 0.96$).

**Conclusion:** The Persian version of the CSP-2 can efficiently differentiate sensory processing patterns, sensation, and behavioral areas between typically developing children and children with CP. The excellent internal consistency and reproducibility of results in test-retests indicate that the Persian version of the CSP-2 is a valid and reliable tool to assess sensory processing in children with CP.

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## Introduction

Cerebral Palsy (CP) refers to some disorders caused by static lesions to a developing brain during the prenatal phase up to the second year of life (1). The condition is life-lasting, affecting individuals' posture, muscle tone, and movements due to the coexistence of spasticity and contractures in this disorder (1,2). The prevalence of CP is estimated 2/11 at 1000 births. Motor problems of children with CP usually coexist with sensory, perceptual, cognitive, communicative, behavioral, and musculoskeletal disorders (3). Research has shown that children with physical disabilities, such as CP, show more limitations in participation due to processing, sensory, and motor problems in comparison with typically developed children (4,5). The sensory inputs provide guidance

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and feedback to successfully establish and correct an error in a movement. Children with CP receive and process different sensory inputs with constraints due to problems in muscle tone, posture, and movement patterns. The probability of deterioration in the white matter of the brain, thalamus, and organs responsible for sensory processing indicates that sensory disorders may lead to functional problems in CP (6). Sensory processing is a neurobiological process, including registration and regulation by the nervous system. The sensory inputs from the outside or inside the body should be organized and integrated to enable the individual to respond appropriately to task and environment demands. Additionally, this process enables individuals to perform Activities of Daily Living (ADL) and engage in meaningful occupations, while sensory processing establishes a connection between cognition, behavior, and participation (6). Sensory issues in children with CP, besides problems with movement and posture, cognition, perceptual skills, and behavior, negatively affect their development and their ability to perform ADL and occupations and their functional independence (7). Research on this topic indicates that most individuals with CP face sensory issues in multiple areas, including visual, proprioceptive, tactile, and motor impairment (8–10). Despite growing evidence on this topic, the assessment of sensory problems is not generally incorporated into rehabilitation practice(4). Identifying problems or disorders related to sensory processing disorders is conceivable with standard tools. Due to the impact of sensory disorders on motor performance and participation, accurately evaluating sensory processing disorders is crucial in the CP population. However, Iran lacks a valid and reliable tool to assess different patterns of sensory processing in children with CP. This study aims to measure the psychometric properties of the Sensory Profile-2 (SP-2) in children with spastic CP and to compare the sensory processing patterns of children with CP with those of typically developing children.

# Materials & Methods

### *Study design*

A cross-sectional study design was employed to examine the validity and reliability of the Persian version of SP-2in children with CP aged 3-14 years old.

### *Population*

The sampling method used for this research is convenience sampling, and all participants voluntarily participated in this study and received no credit for their participation. In order to meet the sample size, 143 children with CP and their parents entered the study, and to evaluate divergent validity, 40 children with CP and their TD peers participated in the current study. Schools, rehabilitation clinics, and schools for students with physical impairment in Tehran, Iran, were visited during 2022-2024 for the sampling procedure. Inclusion criteria were being between the ages of 3and 14 for children, having a confirmed medical diagnosis of CP, having caregivers who were able to read and comprehend Farsi to provide valid responses, and having spastic CP (for the group of children with physical impairment). The exclusion criteria: Participant unwilling to be part of this research or having disability other than CP, having visual or auditory impairments, seizures, or comorbid diagnoses such as autism spectrum disorder, genetic syndromes, or severe intellectual disability affecting sensory function, or involvement in intensive behavioral or pharmacological therapies targeting sensory or behavioral symptoms.

### *Ethical Guidelines*

Informed consent was obtained from all human adult participants and the parents or legal guardians of minors. The ethical approval of this study was obtained from the office of graduate studies in the Rehabilitation Faculty of Shahid Beheshti University of Medical Sciences.

#### *Sample evaluation tools*

Demographic questionnaire for gathering demographic data (age, gender, type of disability, educational level of family, type of residency, and birth order) of the participants.

#### *Sensory Profile-2*

The parent/caregiver form of the SP-2 was used as a standard evaluation of children's sensory processing patterns (seeking, avoiding, sensitivity, registration). The questionnaire, developed by Dunn, consists of 34 items (14 for sensory processing and 20 for sensory processing-related behaviors), offering the most efficiency for ages 3-14. The scoring system is based on a Likert scale of 0= does not apply, 1= almost never, 2= occasionally, 3= half the time, 4= frequently, 5= almost always. The questionnaire has been translated into Farsi by Shahbazi et al. (11). The confirmatory factor analysis supported the original four-factor model proposed by Dunn, consisting of Registration, Seeking, Sensitivity, and Avoiding ($p < 0.05$), suggesting that the Persian version of the Child SP-2-2 (CSP-2) retains the structural integrity of the original instrument and is appropriate for use in the Iranian context(12). The reliability in TD children was also measured. The internal consistency was reported with Cronbach's alpha ranging from 0.79 to 0.93 for different sections

of the questionnaire, and the interclass correlation coefficient (ICC) with an interval of 7-21 days was 0.93-0.97, showing excellent reliability in TD children (11).

**Table 1.** Demographic characteristics of children with CP (n=143)

| Characteristic | Frequency | Percent |
|---|---|---|
| VFCS level | | |
| I | 21 | 14 |
| II | 27 | 18 |
| III | 34 | 23 |
| IV | 33 | 23 |
| V | 28 | 19 |
| GMFCS level | | |
| I | 28 | 19 |
| II | 29 | 20 |
| III | 38 | 26 |
| IV | 30 | 20 |
| V | 18 | 12 |
| MACS level | | |
| I | 32 | 22 |
| II | 34 | 23 |
| III | 35 | 24 |
| IV | 23 | 16 |
| V | 19 | 13 |
| CFCS level | | |
| I | 12 | 8 |
| II | 25 | 17 |
| III | 66 | 46 |
| IV | 25 | 17 |
| V | 15 | 10 |
| Type of CP | | |
| Spastic Hemiplegia | 34 | 23 |
| Spastic Diplepia | 48 | 33 |
| Spastic Quadriplegia | 37 | 25 |
| Ataxia | 11 | 7 |
| Athetoid | 13 | 9 |

**VFCS**: Visual Function Classification System, **GMFCS**: Gross Motor Function Classification System, **MACS**: Manual Ability Classification System, **CFCS**: Communication Function Classification System, **CP**: Cerebral Palsy

### *Psychometric properties*

Translation: To investigate the psychometric properties of the Child SP-2,the Persian version of the SP-2 (11) was used to assess the reliability and validity of this tool in the CP population.

### *Face validity*

In order to measure face validity, ten parents of children with CP and 10 Occupational Therapists with at least 2 years of experience in working with children with CP were asked to answer a 3-point Likert scale questionnaire ( yes, somehow, no) based on the comprehensibility and simplicity of the approved translated version of this test (11).

### *Divergent validity*

Construct validity concerns the extent to which a test or measure accurately assesses what it is supposed to(13). Divergent validity was used to measure the difference between TD children and children with CP. To achieve this goal, scores of the SP-2 between 50 TD children and 50 children with CP were compared using the Spearman correlation coefficient. Spearman's rank of 0.00 to 0.19 is interpreted as too weak, between 0.2 and 0.39 weak, 0.4 and 0.59 moderate, 0.6 and 0.79 strong, and above 0.8 too strong (14).

### *Reliability*

Internal consistency was measured using Cronbach's α with a sample size of 143 children with CP. Cronbach's $\alpha > 0.8$ represents good internal consistency. An alpha ranging from 0.7 to 0.79 represents a moderate level, and an alpha under 0.7 represents an inadequate level of internal consistency (14).

### *Test-retest reliability*

To measure test-retest reliability, ICC was used, and the SP-2questionnaire was filled out at an interval of two weeks by 40 parents of children with CP. ICC <0.4 indicates weak reliability. An ICC ranging between 0.4 and 0.7 indicates rather good reliability; an ICC above 0.7 is interpreted as excellent reliability(14).

### *Data analysis*

Data from the current study were analyzed using SPSS-26 software. Initially, the normal distribution of variables was tested by the Kolmogorov-Smirnov test, which verified the first hypothesis that variables were normally distributed ($p \geq 0.05$). Accordingly, Spearman's correlation rank was used to determine divergent validity.

## Results

The mean age of the participants was 5.85 ± 6.32, witha minimum of three and a maximum of 14 years old, and 77% of the participants were female. The parents' mean age was 36.2 ± 4.30. Other demographic data of participants based on different classification systems, such as the Visual Function Classification System (VFCS), Gross Motor Function Classification System (GMFCS), Manual Ability Classification System (MACS), and Communication Function Classification System (CFCS), were gathered in Table 1.

### *Face Validity*

The process of measuring face validity revealed that 90% (9 out of 10 parents with children with CP) and all of the occupational therapists found the translation quality and clarity of the Persian version of the SP-2 appropriate to measure the sensory processing of children with CP.

***Construct Validity (Divergent Validity)***

Spearman's correlation rank was used to measure divergent validity. Results showed that the Persian version of the SP-2could differentiate children with CP and peer TD children in all dimensions ($p < 0.001$). Data is provided in Table 2.

**Table 2.** Divergent validity of SP-2 in children with CP (n=40)

| Area | Children with CP | Normally developing peers | Effect size (r) | Level of Significance (p) |
|---|---|---|---|---|
| **Quadrant (sensory pattern)** | | | | |
| Seeking | [1.24–2.13] | [1.96–1.85] | −0.42 | p < 0.001* |
| Avoiding | [1.٠4–2.03] | [1.46–1.45] | −0.33 | p < 0.001* |
| Sensitivity | [1.30–3.03] | [1.19–1.22] | −0.61 | p < 0.001* |
| Registration | [1.54–2.43] | [1.16–1.67] | −0.21 | p < 0.001* |
| Auditory | [1.44–2.78] | [1.٠6–1.49] | −0.42 | p < 0.001* |
| Visual | [1.32–1.90] | [1.16–1.45] | −0.40 | p < 0.001* |
| Touch | [1.14–2.0] | [1.03–1.91] | −0.54 | p < 0.001* |
| Movement | [1.66–2.09] | [1.05–1.45] | −0.49 | p < 0.001* |
| Body position | [1.08–1.03] | [1.16–2.48] | −0.71 | p < 0.001* |
| Oral | [1.32–2.15] | [1.55–1.78] | −0.90 | p < 0.001* |
| Conduct | [1.54–2.06] | [1.03–1.93] | −0.51 | p < 0.001* |
| Social-emotional | [1.٠4–2.03] | [1.16–2.45] | −0.30 | p < 0.001* |
| Attentional | [1.54–1.67] | [1.38–1.09] | −0.62 | p < 0.001* |

***Reliability***

***Internal consistency***

The Cronbach's α was used to investigate internal consistency of sensory patterns (avoiding, seeking, sensitivity, and registration), sensations (auditory, visual, touch, movement, body position, and oral), and behavioral areas (conduct, socio-emotional, attention) of the SP-2in children with CP (Table3).

**Table 3.** Cronbach's α for 143 children with the CP in SP-2 scale

| Area | Total (α) |
|---|---|
| **Quadrant (sensory pattern)** | |
| Seeking | 0.86 |
| Avoiding | 0.89 |
| Sensitivity | 0.91 |
| Registration | 0.90 |
| Sensation | |
| Auditory | 0.78 |
| Visual | 0.88 |
| Touch | 0.89 |
| Movement | 0.90 |
| Body position | 0.91 |
| Oral | 0.89 |
| Behavioral area | |
| Conduct | 0.90 |
| Social-emotional | 0.87 |
| Attentional | 0.85 |

***Test-retest Reliability***

Internal correlation coefficient was used to measure test-retest reliability of sensory pattern (avoiding, seeking, sensitivity, and registration), sensation (auditory, visual, touch, movement, body position, and oral), and behavioral area (conduct, socio-emotional, and attention) of the SP-2 in 40 children with CP (Table 4).

**Table 4.** Test-retest reliability of SP-2 in children with CP (n=40)

| Area | Total (ICC) |
|---|---|
| **Quadrant (sensory pattern)** | |
| Seeking | 0.91 |
| Avoiding | 0.92 |
| Sensitivity | 0.88 |
| Registration | 0.87 |
| Sensation | |
| Auditory | 0.90 |
| Visual | 0.96 |
| Touch | 0.91 |
| Movement | 0.89 |
| Body position | 0.91 |
| Oral | 0.89 |
| Behavioral area | |
| Conduct | 0.90 |
| Social-emotional | 0.84 |
| Attentional | 0.86 |

# Discussion

This study aimed to investigate whether the SP-2 is a valid and reliable tool to identify sensory processing disorders in children with CP. As mentioned in different studies (4,15,16), the majority of sensory processing disorders in children with spastic CP are due to proprioception and vestibular system deficits, which can be observed by poor muscle and movement control and balance impairments (17).

When comparing CP children and their TD peers, proprioceptive thresholds are remarkably higher in children with CP (18). The proprioception impairments of children with CP are mostly affected limbs that correlate with equilibrium impairments and worse balance performance(18). Studies that have examined vestibular stimulation in children with CP have

concluded that this intervention can be useful for managing the displacement of the Center of Pressure (COP) seen in children with CP (19).

Studies also reported tactile sensitivity issues in children with CP, affecting their ability to engage in daily activities and social participation (20,21). Disturbances of visual–perceptual abilities affect visual-motor integration, eye–hand coordination, and praxis of constructional skills (22). Moreover, Auditory processing difficulties alongside oral processing issues have been addressed in studies investigating sensory patterns in children with CP (17). Although neuroimaging equipment and previous tests, such as the Sensory Integration and Praxis Test (SIPT), can be useful in detecting sensory processing difficulties, they are not ideal tools for clinical settings to study sensory modulation and sensory behaviors in children. Hence, regarding the latest articles measuring tool, CSP-2, its transcultural adaptation and psychometrics seem essential. SP-2 has been validated in different populations and countries such as Central Auditory Processing Disorder (CAPD) (23), in Korean children with Autism Spectrum Disorder (ASD) (24), Indian children with CP (25), and Iranian children with ASD and Learning Disability(LD) (26), and children with Attention Deficit Hyperactivity Disorder (ADHD) (27).

A study conducted by Dhiman et al. has investigated the psychometric properties of CSP-2 in individuals with CP (25), and the following properties have been calculated: Face validity, content validity, internal consistency, and split-half reliability. Results showed excellent internal consistency for the total items of CSP-2, representing internal homogeneity of the items(25). Cronbach's α for sensory processing quadrants demonstrated good internal consistency (25), with registration being the highest among quadrants. Furthermore, in the dyslexic population, the Cronbach's α for the sensory quadrants was excellent for seeking, sensitivity, and registration, avoiding (28).

In the current study, the internal consistency reliability showed excellent homogeneity, too, with the sample size of 143 children with CP, compatible with Dhiman et al.'s study with the sample size of 230 children with CP (25). Given the high value of Cronbach's α, with sensitivity being the highest among the quadrants, conduct among behavioral areas, and body position among sensation, it can be inferred that the subsections and the total questionnaire have good reliability. Test-retest reliability with an interval of two weeks showed excellent test-retest reliability too, aligned with the findings of the other study in children with CP that used split-half reliability (25).

This study confirmed that CSP-2 has good face and content validity and can appropriately differentiate children with CP and TD children based on their sensory processing patterns, and also is a valid and reliable tool to be used in clinical settings. The recent study on individuals with CP did not assess any forms of construct validity, which is crucial for demonstrating a tool's ability to distinguish between what it is intended to measure and what it is not. However, the current study confirms the hypothesis that CSP-2 can effectively differentiate between children with CP and their typically developing peers.

## In Conclusion

The CSP-2 provides a comprehensive assessment of children's sensory processing traits and is used in clinical settings. It also describes how children react to sensory inputs and engage in different activities, enabling useful advice for therapists and parents concerning children with CP dealing with sensory processing deficits. The current study stated that CSP-2 is a valid and reliable tool to be used in clinical settings and to address sensory processing deficits in children with CP.

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**Authors' Contribution**

The study was designed by Malek Amini and Marzieh Pashmdarfard, who supervised the data collection process and performed the data analysis. Marzieh Pashmdarfard was responsible for manuscript writing and data analysis. Sama Rasouli Osalou and Navid Mirzakhani contributed to the study design, reviewed the results, and revised the final manuscript. Author Winnie Dunn conducted the literature review and assisted in manuscript writing and editing.

**Conflicts of Interest**

The authors declared no conflict of interest.

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