Development and validation of an Arabic pediatric sensorimotor development test

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Abstract

Aim: The main concern of Arab rehabilitation therapists is the paucity of a valid clinical assessment tool that fits the demographic and cultural specificities of the pediatric population. This study aimed to describe and validate a localized evidence-based instrument for assessing sensorimotor development in Saudi Arabian children.

Methods: The Arabic Pediatric Sensorimotor Development Test (A-P-SMDT) designed for Saudi Arabian preschoolers was used for 110 children (3–6 years) in this prospective cross-sectional study. The instrument has two constructs: sensorimotor integration and visual perception and visuomotor integration. Five clinicians and 25 senior clinicians reported good face validity. The content validity index test of the test matches a content domain. Cronbach’s α coefficient was 0.95, indicating excellent internal consistency. The Kaiser–Meyer–Olkin test and Bartlett’s test of sphericity were used to test internal consistency. A Kaiser–Meyer–Olkin measure for sampling adequacy was 0.80. Bartlett’s test of sphericity was significant (chi-square = 3400.43, df = 122, p = .00), indicating that the 10 test domains had a good level of correlation.

Conclusion: The preliminary results on the Arabic Pediatric Sensorimotor Development Test showed acceptable reliability and validity, which could be useful for identifying children at risk of sensorimotor development disorders and delays in a mainstream non-clinical population.

Key Messages

This study was the first to validate the development of an ethnically and culturally appropriate clinical assessment tool of sensorimotor skills among a Saudi Arabian pediatric population that could serve multidisciplinary practitioners. The 10 Arabic pediatric sensorimotor test domains showed good correlation. The assessment items had good content validation.

Introduction

Rehabilitation therapists help children with disabilities to participate in their environments, including school and home, and they treat children with injuries with the aim of assisting with recovery and improving their skills [1]. Nonetheless, for an appropriate evidence-based assessment, therapists need a valid clinical assessment tool [2] that fits the demographics and cultural specificities of children receiving the services. Researchers have recommended that the social, cultural and neurocognitive aspects of a population should be considered in a test [3–5]. Additionally, the identification of effective therapy programs requires a validated outcome measurement tool to capture a child’s behavioral improvement [6]. To date, there is no validated clinical tool in rehabilitation therapy for the assessment of sensorimotor development in Saudi Arabian children. Saudi Arabia’s pediatric population is 10.8 million people and accounts for 31.4% of the general population, which is 34.2 million people [7]. Despite the increase in the pediatric population, the prevalence of sensorimotor developmental delays amongst children in Saudi Arabia is unknown; however, it is believed that the number of children with developmental delays has been increasing due to the scarcity of early...
screening and intervention programs. More than 5 million children are within the age range of 0–8 years.

According to global statistics, Arabic was ranked the fifth most spoken language, with more than 280 million speakers [8]. The main concern of therapists in Arabic countries, including Saudi Arabia, is the paucity of standardized assessments in Arabic for the pediatric population [9]. In Saudi Arabia, the first rehabilitation in physical therapy program was established in the mid-1980s, which was soon followed by speech pathology and audiology programs at King Saud University. Occupational therapy was introduced in 2012. According to studies in Saudi Arabia and surrounding regions, low competency standards concerning evidence-based assessment and treatment were observed amongst rehabilitation clinicians [10,11]. The top barriers to evidence-based practice amongst physical therapists were the lack of resources such as clinical motor functional tests and the inapplicability of the cross-cultural research findings to the local patient population [12].

Cross-cultural standardized clinical tests are not considered psychometrically reliable or valid for assessing Saudi Arabian children because of the variation in culture and ethnicity; hence, there is a great need for a test that assesses sensorimotor skills that is validated on Saudi Arabian children, as these skills, which reflect engagement in activities of daily life, are important in a child’s development.

The development of rehabilitation scales is also useful for therapeutic and educational programs [13]. Rehabilitation therapists can help pre-school and kindergarten teachers to organize classroom activities that help children develop the readiness skills needed for motor and visual perception and visuomotor integration. Developing and validating locally reliable measurement instruments yield valid data for researchers in pediatric rehabilitation in Saudi Arabia that may be used for sampling, concurrent validity tests and outcome measures of intervention programs.

The aim of this study was to develop and validate a demographically and culturally appropriate sensorimotor development test that is relevant to Arabic occupational, physical and speech therapists and related professionals involved in the developmental and physical rehabilitation of Arabic speaking children in hospitals, rehabilitation centers, schools and health and human services centers. It was hypothesized that items would be explained by at least a 10-factor model with high internal consistency.

2. Materials and methods

2.1. Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The study was approved by the institutional ethics committee. Written informed consent was obtained from the parents.

| Table 1 | Participant demographics (n = 110). |
|---------|------------------------------------|
| **Age (years)** | **(n = 110)** |
| 3 | 25 (22.7) |
| 4 | 32 (29.1) |
| 5 | 53 (48.2) |
| **Sex** | **(n = 110)** |
| Female | 50 (45.5) |
| Male | 60 (54.5) |

Values are presented as n (%).

2.2. Study design

This prospective cross-sectional study was conducted at public and private pre-schools in Riyadh, Saudi Arabia, after obtaining approval from the institutional ethics committee (No. CAMS 150-36/37) and from the Ministry of Education (No. 37972368). Consent was obtained from parents through each school administration. The sample recruited was of Arabic, monolingual, typically developing Saudi pre-school children of different socioeconomic status with no history of communication, neurodevelopmental, sensorimotor, cognitive, or socioemotional delays or disorders. Reports of teachers and parents to school administration and observation of three international and national expert clinicians were used as sources of data for the typicality of children. All children participated voluntarily. All children’s identities were processed with confidentiality by assigning a number code for each child for further reference. Children were selected randomly from classrooms in different pre-schools in Riyadh.

2.3. Procedure

The Arabic Pediatric Sensorimotor Development Test (A-P-SMDT) consists of two major constructs, namely, sensorimotor integration and visual perception and visuomotor integration. Each construct consisted of different themes: gross motor, fine motor, bilateral coordination, tactile discrimination, eye-hand coordination, copying, perception, visual closure and drawing a person. A scoring scale was developed for each item, with scores ranging from 3 (complete target behaviour), 2 (emerging behaviour), 1 (behaviour attempted) to 0 (lack of behaviour). A procedure manual was written for standardized test administration (Appendix 1), and a scoring record was included (Appendix 2). Uniform culturally and developmentally appropriate materials across examiners were prepared for the test. The materials for performing tasks are shown in appendices 3 and 4.

Data were collected from each child at his or her pre-school in an open comfortable space with minimal environmental noise or distractions, where children were seated at child-friendly chairs with tables for relevant tasks. Two examiners administered and scored the test for each child for reliability of scoring. Once a test was completed, the 2 examiners reviewed and validated the scoring and coding of data. A criterion of 85% reliability was set for the scoring and coding reliability. The validated data were then entered into Excel spreadsheets (Microsoft, Redmond, WA, USA) on Google Docs. An expert clinician supervisor reviewed and validated the data entry, and reliability was >85%.

Four rehabilitation experts rated the relevance of each item to the behavior domain on a 4-point scale, with 1 = not relevant, 2 = somewhat relevant, 3 = quite relevant and 4 = highly relevant. Calculation of this rating yielded the content validity index (CVI) [14]. The review process determined whether the items fit the designed constructs, themes and objectives of the test, and whether they were consistent with the criteria for content and face validity. Following the content validation process, 4 clinicians and
25 senior student clinicians in occupational therapy underwent training and administered the test to validate the clarity and suitability of the items and scoring to the end user, thus obtaining face validity.

2.4. Statistics

Raw data were exported to SPSS version 19.0 (IBM Corp., Armonk, NY, USA) for generation of descriptive statistics and statistical analyses. To test internal consistency, Cronbach’s $\alpha$ was used as the most widely applied index [15,16], with a coefficient $\geq 0.80$. To evaluate the suitability of the data set for factor analysis for construct validity, the measure of sampling adequacy, Kaiser–Meyer–Olkin (KMO) and Bartlett’s test of sphericity were applied. Both measures indicate the strength of the relationships amongst the test items. A KMO index $>0.5$ indicates that a factor analysis is applicable to the test items’ data set. A significance level of 0.00 for the Bartlett’s test of sphericity indicates a strong relationship amongst the test items’ data set; hence, the factor analysis of the data set is viable.

3. Results

The sample comprised 50 girls and 60 boys, for a total of 110 children, with an average age of 4.8 (0.9) years. Table 1 shows the demographic data of the participants. The effect of sex was not significant [mean (standard deviation): female, 2.4 (0.14); male, 2.3 (1.7); two-tailed t-test $=1.45$, $p = .15$]. Content validity that measured the extent to which the test represents all facets of skills within each domain showed a CVI of 3.45, indicating good evidence of the degree to which the content of the test matches a content domain associated with the constructs.

The Cronbach’s $\alpha$ coefficient was 0.95, indicating excellent internal consistency. The KMO measure of sampling adequacy was 0.80, which is greater than the threshold of 0.7. The result of Bartlett’s test of sphericity was significant (chi-square $= 3400.43$, df = 122, $p = .00$), indicating that the 10 test domains were not independent and have a good level of correlation. Thus, factor

| Item | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| A1   | 0.19| 0.24| 0.70| 0.03| 0.13| -0.08| 0.18| 0.03| 0.35| -0.00| 0.07| 0.14| -0.01|
| A2   | 0.28| -0.00| 0.24| 0.25| 0.26| 0.06| 0.17| 0.50| 0.09| 0.11| 0.09| -0.04| 0.18|
| A3   | 0.01| 0.27| 0.73| 0.14| 0.09| 0.19| 0.02| -0.06| -0.05| -0.04| -0.06| -0.01| 0.06|
| B14  | -0.07| 0.36| 0.47| 0.31| 0.09| 0.09| 0.13| -0.18| -0.02| 0.22| -0.09| 0.15| -0.09|
| B16  | 0.02| 0.13| -0.09| 0.10| 0.00| -0.09| 0.08| -0.03| 0.11| 0.77| 0.05| -0.07| 0.03|
| B19  | 0.24| 0.72| 0.14| 0.15| 0.27| 0.16| -0.03| -0.02| 0.13| 0.24| 0.12| 0.02| 0.08|
| B21  | 0.06| 0.48| 0.33| 0.06| 0.20| 0.13| 0.14| 0.48| 0.15| 0.11| 0.24| 0.05| 0.09|
| B23  | 0.21| 0.22| 0.17| 0.34| 0.22| -0.12| -0.04| 0.07| -0.09| -0.06| 0.25| -0.25| -0.25|
| B25  | 0.05| 0.56| 0.16| 0.06| 0.24| 0.13| 0.04| 0.37| 0.04| 0.15| 0.16| -0.08| 0.04|
| B27  | 0.19| 0.77| 0.22| 0.19| 0.13| 0.09| 0.01| 0.17| 0.06| 0.04| -0.06| 0.04|
| B30  | -0.14| 0.33| 0.28| 0.12| -0.13| 0.03| 0.19| 0.39| -0.01| -0.11| -0.01| -0.22| 0.01|
| C22  | 0.04| 0.09| -0.03| 0.14| -0.15| 0.13| 0.00| 0.79| 0.22| 0.02| 0.00| 0.04| 0.04|
| C24  | 0.16| 0.09| 0.24| 0.15| 0.04| 0.04| 0.67| 0.24| 0.26| 0.04| 0.11| -0.05| 0.19|
| C26  | 0.19| 0.11| 0.05| 0.04| 0.19| 0.09| 0.29| 0.57| 0.05| -0.24| -0.11| 0.04| 0.25|
| C28  | 0.04| 0.45| 0.07| 0.19| 0.09| 0.18| 0.18| 0.55| 0.18| 0.02| 0.15| 0.04| 0.02|
| C30  | 0.09| 0.23| 0.42| 0.19| 0.19| 0.10| 0.07| 0.21| 0.08| 0.15| 0.12| 0.16| 0.11|
| C32  | 0.22| 0.44| 0.31| 0.58| 0.15| -0.04| 0.19| 0.12| 0.17| 0.07| -0.02| 0.10| 0.07|
| C34  | 0.18| 0.45| 0.33| 0.53| 0.16| 0.08| 0.22| 0.19| 0.18| 0.06| 0.01| -0.01| 0.09|
| C36  | 0.26| 0.44| 0.31| 0.58| 0.15| -0.04| 0.19| 0.12| 0.17| 0.07| -0.02| 0.10| 0.07|
| C38  | 0.03| 0.31| 0.04| 0.46| 0.21| 0.08| 0.09| 0.20| -0.05| 0.30| 0.18| 0.12| 0.09|
| C40  | 0.01| 0.13| 0.18| 0.09| 0.01| 0.08| 0.05| 0.13| 0.05| 0.02| 0.09| 0.16| 0.78|
| C42  | 0.02| 0.18| 0.11| 0.48| 0.08| 0.12| 0.23| 0.49| 0.18| 0.17| 0.02| 0.04| 0.04|
| C44  | 0.32| 0.38| 0.33| 0.31| 0.30| 0.27| 0.17| 0.33| 0.04| 0.08| 0.14| 0.02| 0.04|
| C46  | 0.13| 0.09| 0.07| 0.06| 0.06| 0.04| 0.05| 0.07| 0.09| 0.06| 0.06| 0.06| 0.04|
| C48  | 0.14| 0.16| 0.06| 0.09| 0.07| 0.09| 0.43| 0.13| 0.18| 0.06| 0.06| 0.04| 0.06|
| C50  | 0.11| 0.14| 0.16| 0.21| 0.81| 0.06| 0.07| 0.02| 0.08| 0.04| 0.15| -0.02| 0.04|

Table 3: Arabic Pediatric Sensomotor Development Test item factor analysis rotated component matrix (n = 110).
analysis was suitable for the extraction of component factors to test construct validity. Table 2 shows the mean test scores of 52 items on a scale of 0–3. Fifty-two test items were loaded on the factor analysis using principal components analysis with orthogonal varimax rotation of the item scores. Thirteen factors were extracted, in bold as shown in Table 3. Since the A-P-SMDT measures multidimensional skills in sensorimotor functions, it was expected that the items would load on the different factors.

Exploratory factor analysis loaded 52 items with a 10-factor solution (gross motor, fine motor, bilateral coordination, tactile discrimination, eye-hand coordination, copying, perception, visual closure, visual memory and drawing a person) that jointly accounted for 100% of the observed variance. The confirmatory factor analysis indicated a good fit to the data. Factor analysis identified a 13-factor structure of the test (Table 3). These factors displayed good internal consistency.

4. Discussion

The preliminary results of this study indicate that the A-P-SMDT is promising as a valid instrument for measuring the pediatric sensorimotor functions of Saudi Arabian preschoolers. Content validity results answered the question as to whether the test items covered a representative sample of areas for motor, visuomotor coordination and integration skills discussed in the scientific literature that should be assessed in preschoolers [17]. Good face validity was confirmed by two international expert scholars, five clinicians and 25 senior student clinicians, indicating that the test items are clear, suitable and easy to use.

The factor structure of the test evaluation showed that items load most on the theorized scales, indicating construct validity [18–20]. The result of construct validity provides evidence of empirical and theoretical support for the interpretation of the constructs. Such lines of evidence include statistical analyses of the internal structure of the test, including the relationships between responses to different test items. Results of internal consistency tests revealed a high level of reliability. This initial test for Saudi Arabian children meets the literature recommendation that therapists should only use assessment tools that show established validity and reliability [21], as they are clinically useful instruments. This test provides a broad spectrum of skills assessment that covers sensory, motor, cognitive and bilateral sensorimotor coordination and integration that are necessary to identify the sensory and motor factors influencing the development of a Saudi Arabian child. Moreover, the study reported a high internal consistency and construct validity, which are the most commonly cited pediatric test psychometrics in the literature [22]. Hence, the study reliability and validity results make the test a viable part of the evaluation process in occupation therapy, physical therapy and related rehabilitation clinical settings, along with clinical observations and parents’ questionnaires. This tool was created with clear standardized instructions, as attested by the content face validation of end users, an easy-to-use scoring form, and familiar and easily obtainable materials, which may facilitate assessment for healthcare practitioners [23]. Unlike translated and adapted tests [24,25], this tool was created from within the specificity of the local Saudi culture.

A limitation of the study was the small sample size. As this phase of the study is preliminary, more sample data will follow. Furthermore, more psychometric measures are underway, including test-retest and concurrent validity measures. The high internal consistency and construct validity add to the strengths of this tool. The fact that it was designed by experts within the local community of its end users and was directly tested on them adds value to this tool. One of its possible applications is in the collection of developmental data for Saudi Arabian children.

The findings of this study showed that the designed test was a valid and reliable instrument for measuring Saudi Arabian pediatric sensorimotor skills in the pre-school context. It is an easy-to-use test and contains the most significant sensory- and motor-related behaviors that are involved in daily activities and children's ability to interact with the environment in order to learn and grow. The A-P-SMDT could be introduced to clinical practice as an evidence-based clinical assessment tool for developmental delays and disorders. Further studies to examine more psychometric properties of the test, including a clinical sample within clinical practice, are recommended.

Ethics approval statement

The study was approved by the committee of scientific research ethics at King Saud University (no. CAMS 150-36/37), the Ministry of Education, and the Department of Planning (no. 37972368). Appropriate patient consent was obtained.

Declaration of competing interest

The author declares no conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jipam.2021.03.005.

Visual abstract

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