Criterion validation of 'learning difficulty related items' in INCLEN- NDST against NIMHANS battery among children with suspected learning problems

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Abstract

Keywords:

- Specific Learning Disorder
- NDST-Research Form
- NIMHANS Battery
- Pediatric Screening
- Learning Difficulties
- Criterion Validation

Background:

The prevalence of learning difficulties is increasing in recent years as a result of better awareness, support systems and better neonatal care. Many tools available in this domain are western and effective screening tools are rare in the Indian context.

Objective:

To evaluate the criterion validity of the Neurodevelopmental Screening Tool (NDST-Research form) as a screening tool for learning difficulties in children aged 7-13 years, using the NIMHANS Battery as the gold standard diagnostic tool.

Methods:

This hospital-based criterion validation study was conducted, over eight months. Forty consecutive children aged 7-13 years with suspected learning problems were screened using the NDST-Research form, followed by assessment with the NIMHANS Battery for Specific Learning Disability (SLD). The NDST-Research form was administered by a Developmental Nurse Counsellor, while the NIMHANS Battery was conducted by a consultant clinical psychologist, blinded to the screening results. Statistical analysis with SPSS version 20, calculated sensitivity, specificity, predictive values, diagnostic accuracy, and likelihood ratios.

Results:

NDST-Research form: 35 children (87.5%) screened positive for SLD, while 5 children (12.5%) did not. NIMHANS Battery results: 34 children (85%) diagnosed with SLD, while 6 children (15%) were not. NDST-Research form had a sensitivity: 97.06%; specificity: 66.7%; Positive Predictive Value (PPV): 94.29%; Negative Predictive Value (NPV): 80%; Positive Likelihood Ratio: 1.48; Negative Likelihood Ratio: 0.46, and Diagnostic Accuracy of 92.5%

Conclusion:

The acceptable psychometric properties suggest that NDST can be used in pediatric outpatient clinics for early identification, enabling timely intervention given the

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high prevalence of attention deficits, arithmetic difficulties, and reading/writing impairments to improve early detection and intervention strategies.

Introduction

According to DSM-5, Specific Learning Disorder is defined as persistent difficulties in reading, writing, arithmetic or mathematical reasoning, with academic skills well below average scores [1]. The NIMHANS battery for Specific Learning Disability (SLD) characterizes it as a performance level three grades below the child's current academic standard [2]. The INCLEN study, conducted across five regions in India, reported a community prevalence of SLD at 1.6% (95% CI: 1.0–2.5) among children aged 6 to 9 years, utilizing the Grade Level Assessment Device (GLAD) [3]. In a cross-sectional, school-based study in Ernakulum, the prevalence of SLD was found to be 16.49% (95% CI: 14.59–18.37), with impairments in reading, written expression, and mathematics being 12.57%, 15.6%, and 9.93%, respectively. Binary logistic regression analysis identified male gender, low birth weight, developmental delay, family history of poor scholastic performance, and syllabus as independent factors associated with SLD[4].

The administration of the NIMHANS battery in a school setting is impractical without a trained psychologist, necessitating an alternative approach. According to the Australian Disability Clearinghouse on Education and Training, learning difficulty is defined non-categorically, encompassing individuals who experience challenges in acquiring one or more basic academic skills[5] This definition emphasizes functional educational difficulties, which may be amenable to interventions, rather than the primary etiology. The Learning Disabilities Association of America has proposed broad-spectrum intervention strategies that may benefit children with learning difficulties[6]. Consequently, the objective of a screening tool should be to identify children at risk for learning difficulties, enabling the implementation of appropriate interventions.

The Neurodevelopmental Screening Tool (NDST-Research form), developed by the INCLEN-NDD study team under the leadership of Arora NK, is a 39-item screening instrument that assesses 10 neurodevelopmental disorders, including four specific questions related to SLD. A failure in any one item is considered a failure of the test. According to a gazette notification by the Ministry of Social Justice and Empowerment, the NIMHANS battery for SLD is designated as a diagnostic assessment tool for certifying benchmark disability in India[7].

Rationale: Diagnostic tools for identifying Specific Learning Disability require extended administration time, highlighting the need for screening to identify 'at-risk' children. Early identification during the initial school years (from age 7 onwards) is crucial for facilitating timely intervention. Therefore, this study aims to determine the criterion validity of the 'LD-related items' in the NDST-Research form as a screening tool, with the NIMHANS battery serving as the diagnostic tool administered by a trained psychologist.

Objectives

1. To administer neurodevelopmental screening tool (NDST- Research form) screening test among children in the age group of 7-13 years with suspected learning problems attending NIMS spectrum CDRC.
2. To administer NIMHANS battery for SLD tool among the same children.
3. Criterion validation of LD related items in neurodevelopmental screening tool (NDST-Research form) against (NIMHANS battery) as gold standard for specific learning disabilities and to calculate sensitivity, specificity, predictive values, diagnostic accuracy and likelihood ratios.

Methods

The present study is a hospital based criterion validation study which was carried out from January to August 2022 over a period of 8 months, at Thiruvananthapuram NIMS-Spectrum-Child Development Research Centre (CDRC), Noorul Islam Centre for Higher Education (NICHE), Deemed-to-be University. Forty consecutive children 7-13 years of age with suspected learning problems, coming to NIMS-Spectrum-CDRC, a tertiary care centre for children with neurodevelopmental problems, were included. Ethical clearance was obtained from Institutional Ethical Committee clearance (Regn. No. ECR/218/Inst/Ker/2013/RR-16 and Approval No. NIMS/IEC/2022/01/04, dtd. 10/01/2022) and due consent from each individual parent was obtained. Consecutive 40 children aged 7-13 years who attended the clinic with suspected learning

problems, with at least average intelligence, were included in the study. Children without a primary care giver and non-consenting parents were excluded. LD related items in NDST R/F were used as screening tool and NIMHANS battery for SLD Level 2 as the gold standard test.

Data was collected by interview method. Evaluation using NDST-Research form was done by Developmental Nurse Counsellor and evaluation using NIMHANS battery by consultant clinical psychologist trained in NIMHANS Battery, blind to the screening results. The analysis was performed using Statistical Package for Social Science (SPSS version 20).

Results

Out of the study population of 40 children,

- o Age: 7-10 years – 15; 11-13years – 25.
- o Gender: Male 25 (62.5%); Female 15 (37.5%).

Using NDST-Research form 35 (87.5%) children had at least one question positive suggestive of LD and 5 (12.5%) children did not have any one question positive suggestive of LD (Table.1).

Table 1: Distribution of 'SLD related items' in NDST-Research form (n= 40)

NDST No.	NDST Research form Items			
	School change	No	Required	Dropped out
55a.	Did your child change school/dropped out of school due to poor school performance?	32	8	0
	School performance	No	Some-times	Most times
56a.	Do the teachers complained about your child's poor performance in studies?	7	28	5
58a.	Does your child find it difficult to read or write or do simple calculations?	5	29	6
	Subject specific	No	One subject	Two or more
57a.	Does your child have significant difficulty in any subject?	9	17	14
NDST-Research form Impression = Not suggestive of LD: 5(12.5%); Suggestive of LD: 35(87.5%)				

This study showed that using NIMHANS battery, maximum number of children had issues with attention followed by poor arithmetic skills, reading skills, writing skills, comprehension, spelling, perceptual motor ability and auditory memory in descending order. (Table.2)

Table 2: LD in the NIMHANS Battery Domains (n= 40)

Domains	Adequate No. (%)	Not adequate/ need to improve No. (%)
Attention	7 (17.5)	33 (82.5)
Arithmetic	13 (32.5)	27 (67.5)
Reading	19 (47.5)	21 (52.5)
Writing	21 (52.5)	19 (47.5)
Comprehension	22 (55.0)	18 (45.0)
Spelling	25 (62.5)	15 (37.5)
Perceptual motor ability	28 (70.0)	12 (30.0)
Auditory memory	31 (77.5)	9 (22.5)
NIMHANS Battery Impression= No LD: 6 (15); LD=34 (85)		

On doing criterion validation of 'LD Related items' in NDST-Research form against NIMHANS Battery, the psychometric properties were as follows: sensitivity 97.06%; specificity 66.7%; positive predictive value (PPV) 94.29%; negative predictive value (NPV) 80%; positive likelihood ratio 1.48; negative likelihood ratio 0.46 and diagnostic accuracy 92.5%. (Table 3)

Table 3: 'LD Related items' in NDST-Research form vs NIMHANS Battery

NDST-Research form Impression	NIMHANS Battery Impression		Total
	LD	No LD	
LD	33 (TP)	2 (FP)	35
No LD	1 (FN)	4 (TN)	5
Total	34	6	40

Discussion

Specific Learning Disorder (SLD) is a neurodevelopmental condition that affects academic skills such as reading, writing, and arithmetic, often leading to long-term educational challenges if not identified early [8]. In India, the pooled prevalence of SLD in community and school settings has been estimated at 8% (95% CI: 4–11%), highlighting the need for early identification and intervention [9,10]. However, rather than confirming SLD at a young age, the priority should be identifying learning difficulties early to facilitate timely intervention [11]. The benefit for the participants of this study was the group administration of an intervention module in local language (Malayalam) that focussed on improving; (i) phonemic awareness; (ii) reading; (iii) writing; (iv) copying; (v) number concepts; (vi) mathematical reasoning; (vii) mathematical operations and (viii) visuospatial training.

This study assessed the NDST-Research form as a screening tool for learning difficulties, comparing its results with the NIMHANS Battery, a standardized diagnostic tool. However, the present study did not analyse the grade-level performance of the child while using NIMHANS battery because the intention was to use NDST as a validated screening tool. The findings indicate that 87.5% of children screened positive for learning difficulties using NDST, while 85% were diagnosed with SLD using the NIMHANS Battery, demonstrating strong agreement between the two tools. The criterion validation of NDST against the NIMHANS Battery showed high sensitivity (97.06%) and positive predictive value (94.29%), suggesting that NDST is effective in identifying children at risk for SLD. In this context, the observed sensitivity, Positive Predictive Value, Positive Likelihood Ratio and diagnostic accuracy of LD related items in NDST against NIMHANS battery suggests utility of this simple tool at clinic level. The acceptable psychometric properties of "LD related items" in NDST-research form make it a quick screening tool that could be used in the paediatric OPD setting as well. Among the domains assessed using the NIMHANS Battery, attention deficits were the most prevalent (82.5%), followed by difficulties in arithmetic (67.5%), reading (52.5%), writing (47.5%), comprehension (45%), spelling (37.5%), perceptual motor ability (30%), and auditory memory (22.5%). These findings align with previous studies indicating that attention deficits and arithmetic difficulties are common in children with learning disorders [8,11].

The NDST-Research form demonstrated acceptable psychometric properties, making it a quick and effective screening tool for learning difficulties in pediatric outpatient settings. Given its high sensitivity and diagnostic accuracy (92.5%), NDST can serve as a first-line screening tool, allowing clinicians to identify children who may require further assessment and intervention.

Conclusion:

This study highlights the utility of NDST-Research form as a validated screening tool for learning difficulties in children. The high sensitivity, positive predictive value, and diagnostic accuracy suggest that NDST can be effectively used in pediatric outpatient clinics to identify children at risk for SLD. The findings also emphasize the importance of early intervention, as children with

learning difficulties benefit from targeted support in phonemic awareness, reading, writing, number concepts, mathematical reasoning, and visuospatial training.

Given the high prevalence of learning difficulties, integrating NDST screening into routine pediatric assessments could facilitate early identification and intervention, ultimately improving academic outcomes for children with learning challenges. Future research should explore longitudinal outcomes of children identified through NDST and assess the impact of early intervention strategies on their academic performance.

Conflict of interest: None

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