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RESEARCH ARTICLE

A Multi-Phase Study on the Development and Psychometric Validation of the AHEAD Paediatric Screening Tool

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Abstract: ***Background***: Early identification of paediatric developmental, emotional, and behavioural disorders is a global health priority, particularly in Low- and Middle-Income Countries (LMICs) like India, where validated and culturally-adapted screening tools are scarce. This paper details the systematic, multi-phase methodological framework used to develop and validate the Assessment of Holistic Emotional and Developmental Growth (AHEAD) tool, a comprehensive screening instrument for children aged 1 month to 18 years. ***Methods***: An exploratory sequential study design was employed. The methodology involved: (1) Item pool generation through extensive literature review and multidisciplinary expert consultation; (2) Rigorous content and face validity assessment using quantitative expert ratings to calculate Content Validity Ratios (CVR) and Content Validity Index (CVI) for item reduction; and (3) A pilot study (N=1000, stratified by age) to establish construct validity via Exploratory (EFA) and Confirmatory Factor Analysis (CFA) and to assess reliability using Cronbach's alpha and Intraclass Correlation Coefficients (ICCs). ***Results***: The initial item pools (112 developmental, 125 mood/behavioural) were systematically reduced to 70 final items based on expert consensus (S-CVI > 0.98) and statistical analysis. The final modules (Developmental; Behavioural; Mood 1-6yrs; Mood 6-18yrs) demonstrated strong psychometric properties. CFA confirmed excellent model fit for all mood/behavioural modules (e.g., CFI > .97, RMSEA < .06). The modules showed high internal consistency (Cronbach's α = 0.96 for Developmental; 0.77-0.85 for mood/behavioural modules) and excellent test-retest reliability (ICCs > 0.98). ***Conclusion***: This systematic, multi-phase methodology provides a transparent and replicable framework for developing psychometrically sound, culturally-relevant paediatric assessment tools. The successful validation of the AHEAD tool demonstrates the effectiveness of this approach. This framework can serve as a guide for researchers in LMICs aiming to create new, contextually-appropriate instruments to address the critical gap in child mental health screening.

Keywords:

INTRODUCTION

The early identification of developmental, behavioural, and emotional disorders is a global health priority essential for improving long-term outcomes for children.[1,2] However, in Low- and Middle-Income Countries (LMICs) like India, millions of children with neurodevelopmental disorders (NDDs) and emotional challenges remain undiagnosed.[3] This is largely due to a lack of feasible, culturally appropriate, and standardized screening protocols for use in primary care and community settings.[4,5]

While numerous screening tools exist, many were developed in high-income, Western contexts and may lack cultural, linguistic, or socioeconomic validity for diverse populations.[6] This can lead to poor diagnostic accuracy, under-reporting, and a reliance on instruments with variable psychometric properties.[7] Consequently, there is a critical need not only for new screening tools, but for a rigorous and transparent *methodology* to develop and validate instruments that are culturally-adapted and practical for deployment in resource-constrained health systems.

The development of the Assessment of Holistic Emotional and Developmental Growth (AHEAD) tool was initiated to provide such a comprehensive, holistic, and scalable screening solution for Indian children from infancy through adolescence. This paper provides a detailed methodological framework of its multi-stage development and validation. We describe the sequential process, commencing with (1) item pool generation based on established theoretical frameworks of child development,[8,9,10] (2) qualitative and quantitative face and content validity assessments, including the use of expert panels to establish Content Validity Ratios (CVR) and a Content Validity Index (CVI),[11] and (3) comprehensive psychometric assessment, including construct validation via Exploratory and Confirmatory Factor Analysis (EFA/CFA) and reliability testing. This framework, which culminated in an app-based digital tool, serves as a replicable model for developing and

validating new paediatric assessment instruments in LMICs.

Material and Methods

Study Design An exploratory sequential study design was employed, conducted from January 2023 to December 2024, to rigorously develop and validate the AHEAD screening tool. The study was approved by the Institutional Ethics Committee (IEC-Reference Number: 010/09/2024/IEC/SMCH) at Saveetha Medical College and Hospital. All participants' caregivers provided written informed consent.

Phase 1: Item Pool Generation (Qualitative Phase) An initial comprehensive item pool was generated through two key methods:

1. **Literature Review:** A systematic review of databases (Cochrane, PubMed, Google Scholar) was conducted to identify existing validated screening tools and key developmental, emotional, and behavioural domains.
2. **Expert Consultation:** A panel of 15 experts, including paediatricians, child psychiatrists, clinical psychologists, and speech pathologists, was consulted to generate and refine potential screening questions based on clinical relevance and cultural appropriateness for the Indian context. This phase resulted in 112 items for developmental disorders and 125 for mood/behavioural disorders.

Phase 2: Face and Content Validity Assessment The item pool underwent a two-step validation process to ensure relevance and clarity.

1. **Face Validity:** A panel of 10 experts assessed the items for clarity, comprehensibility, and linguistic simplicity. Items were rated on a 5-point Likert scale, and an Impact Score was calculated. Items with an Impact Score ≤ 1.5 were deleted.
2. **Content Validity:** A panel of 15 experts evaluated the reduced item list. First, the Content Validity Ratio (CVR) was calculated for each item based on Lawshe's method, with items rated as "Essential," "Useful," or "Not Necessary."[12] Items failing to meet a CVR of 0.6 were removed. Second, the remaining items were assessed for relevance on a 4-point Likert scale to calculate the Content Validity Index (CVI).[13] Items with an I-CVI < 0.79 were discarded. This phase resulted in a 41-item developmental tool and a 40-item mood/behavioural tool.

Phase 3: Construct Validity and Reliability (Pilot Study) A pilot study was conducted on a sample of 1000 children (stratified into four age- and domain-specific groups of 250) to finalize the psychometric properties of the tools.

1. **Construct Validity (EFA/CFA):** For the mood and behavioural modules, construct validity was assessed using Exploratory Factor Analysis (EFA). The Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of Sphericity were used to confirm sampling adequacy. Principal Axis Factoring with Direct Oblimin rotation was applied to extract latent factors. The resulting factor structure was then confirmed using Confirmatory Factor Analysis (CFA) in AMOS.
2. **Reliability:** Internal consistency for each module and its subscales was measured using Cronbach's alpha, with a value > 0.7 considered acceptable. Stability was assessed via a test-retest method at a one-month interval, calculating Intraclass Correlation Coefficients (ICC), with ICC > 0.4 considered acceptable.

This multi-phase process finalized the AHEAD modules, which were then integrated into a mobile application for general population testing.

Results:

Results

The methodological process yielded a suite of validated, psychometrically robust screening modules.

Phase 1 & 2: Item Reduction and Content Validity (Table 1): The initial item pool (112 developmental, 125 mood/behavioural) was systematically reduced.

- **Face Validity:** The pool was reduced to 97 developmental items and 106 mood/behavioural items by removing 15 and 19 items, respectively, based on expert ratings (Impact Score ≤ 1.5).
- **Content Validity (CVR):** The list was further reduced by removing 36 developmental and 42 mood/behavioural items with a CVR < 0.6. The resulting Scale-CVR (S-CVR) was 0.798 for the developmental tool and 0.802 for the mood/behavioural tool.
- **Content Validity (CVI):** A final content validation step removed 25 developmental and 24 mood/behavioural items with an I-CVI < 0.78. This resulted in a 41-item developmental tool and a 40-item mood/behavioural tool, both demonstrating excellent content validity (S-CVI = 0.990 and 0.988, respectively).

Phase 3: Construct Validity and Reliability (Pilot Study) (Table 2): The 40-item mood/behavioural tool was split into three modules for construct validation in a pilot study (N=250 for each module).

- **AHEAD-Developmental Module:** This 41-item tool demonstrated excellent internal consistency (Cronbach's α = 0.96). Sub-section alphas were also high: Gross Motor (α = 0.88), Fine Motor (α = 0.87), Language (α = 0.92), and Social/Cognition (α = 0.85).
- **AHEAD-EH (Behavioural) Module:** EFA on 20 items (KMO=.784) yielded a 6-factor solution (69.35% variance) (Figure 1). CFA on a refined 14-item model confirmed an excellent fit (CFI=.979, TLI=.967, RMSEA=.051). The module showed good internal consistency (α = .769) and excellent test-retest reliability (ICC = 0.987).
- **AHEAD-EH (Mood, 1-6 years) Module:** EFA on 10 items (KMO=.798) yielded a 4-factor solution (77.66% variance) (Figure 2). CFA on a refined 9-item model confirmed a good fit (CFI=.990, TLI=.979, RMSEA=.054). The module showed

good internal consistency (α = .852) and excellent test-retest reliability (ICC = 0.986).

- **AHEAD-EH (Mood, 6-18 years) Module:** EFA on 10 items (KMO=.728) yielded a 4-factor solution (74.00% variance) (Figure 3). CFA on a refined 8-item model confirmed an excellent fit (CFI=.989, TLI=.978, RMSEA=.046). The module showed good internal consistency (α = .796) and excellent test-retest reliability (ICC = 0.983).

Final Tool Development The multi-phase validation process resulted in the final AHEAD tool, comprising three distinct, age-appropriate modules with a total of 71 items (41 Developmental, 14 Behavioural, and 16 Mood), which were embedded into a mobile application for clinical and community use.

Discussion

This paper details the systematic, multi-phase methodological framework employed in the development and initial validation of the AHEAD paediatric screening tool. The rigorous approach, integrating literature review, multi-disciplinary expert consultation, sequential validity assessments (face, CVR, CVI), and robust psychometric evaluations (EFA, CFA, reliability testing), addresses common pitfalls in instrument development, particularly for cross-cultural application in LMICs.[7]

The initial phases focused on ensuring content relevance and clarity, critical steps often underemphasized in tool adaptation studies. By utilizing established methods like Lawshe's CVR[12] and Polit & Beck's CVI,[13],[11] we quantitatively assessed expert consensus, resulting in a substantial yet targeted reduction of the initial item pool. This ensured that the retained items were not only theoretically grounded but also deemed essential and relevant by clinicians working within the Indian context. The high final S-CVI values (>0.98) across modules underscore the strong content validity achieved through this iterative refinement process.

The subsequent psychometric phase (Phase 3) confirmed the structural validity and reliability of the developed modules. For the mood and behavioural components, the use of EFA followed by CFA established clear, statistically sound factor structures that align with theoretical constructs of child psychopathology (e.g., social deficits, emotional dysregulation, hyperactivity). The excellent model fit indices obtained in the final CFA models provide confidence in the construct validity of these modules. Furthermore, the high internal consistency (Cronbach's α > 0.76 across all final modules) and outstanding test-retest reliability (ICCs > 0.98 for total scores) demonstrate that the AHEAD modules yield consistent and stable measurements. The developmental module, based on established milestones, similarly showed excellent internal consistency.

This methodological framework holds several strengths. Its sequential nature allowed for data-driven decisions at each stage, ensuring efficiency and rigor. Combining qualitative expert judgment with quantitative statistical analysis provided a balanced approach to item selection and validation. Developing the tool specifically for the target population, rather than merely translating an existing Western tool, enhances its potential cultural validity and acceptability, addressing a key limitation of many tools used in India.[6],[7] Finally, the development culminated in a digital tool, facilitating standardization, ease of use, and scalability.

Limitations of this methodological framework include the potential for selection bias in the expert panels and the reliance on pilot sample data for the initial EFA/CFA and reliability analyses. While rigorous, the CVR/CVI thresholds are conventions, and alternative cut-offs might yield slightly different item sets. The framework described here focuses on the development and initial psychometric validation; the crucial step of evaluating diagnostic accuracy against gold-standard clinical assessments in larger, diverse populations was conducted subsequently (as reported in other potential outputs of this thesis) but is an integral part of the overall validation continuum.

In conclusion, the described methodological framework provides a comprehensive, transparent, and replicable pathway for developing culturally adapted paediatric screening tools in LMICs. The successful application of this framework in creating the AHEAD tool, which demonstrated strong validity and reliability, highlights its utility. This methodology can serve as a valuable guide for researchers and clinicians aiming to develop contextually relevant assessment instruments to address the significant burden of undiagnosed developmental and mental health conditions in children globally.[1],[3],[14]

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Tables:

Validation Stage	Developmental Module Items	Mood & Behavioural Module Items
Initial Item Pool	112	125
After Face Validity	97	106
After CVR	61	64
After CVI	41	40
After EFA/CFA	41 (N/A)	**Total: 29**
		Behavioural: 13
		Mood (1-6 yrs): 8
		Mood (6-18 yrs): 8
Final AHEAD Tool	**41 Items**	**29 Items**

Table 1: Summary of Item Reduction during AHEAD Tool Development

AHEAD Module	Final Items	Internal Consistency (Cronbach's α)	Test-Retest Reliability (ICC - Average Measure)	CFA - CFI	CFA - TLI	CFA - RMSEA
Developmental (1mo-5yr)	41	0.96 (Overall)	N/A (Subscales only)	N/A	N/A	N/A
Behavioural (1-18yr)	13	0.769	0.987	0.979	0.967	0.051
Mood (1-6yr)	8	0.852	0.986	0.99	0.979	0.054
Mood (6-18yr)	8	0.796	0.983	0.989	0.978	0.046

Notes: ICC = Intraclass Correlation Coefficient (based on total score from pilot data); CFI = Comparative Fit Index; TLI = Tucker-Lewis Index; RMSEA = Root Mean Square Error of Approximation. N/A = Not Applicable

Table 2: Summary of Final Psychometric Properties of AHEAD Modules (Pilot Study Data)

Figures:

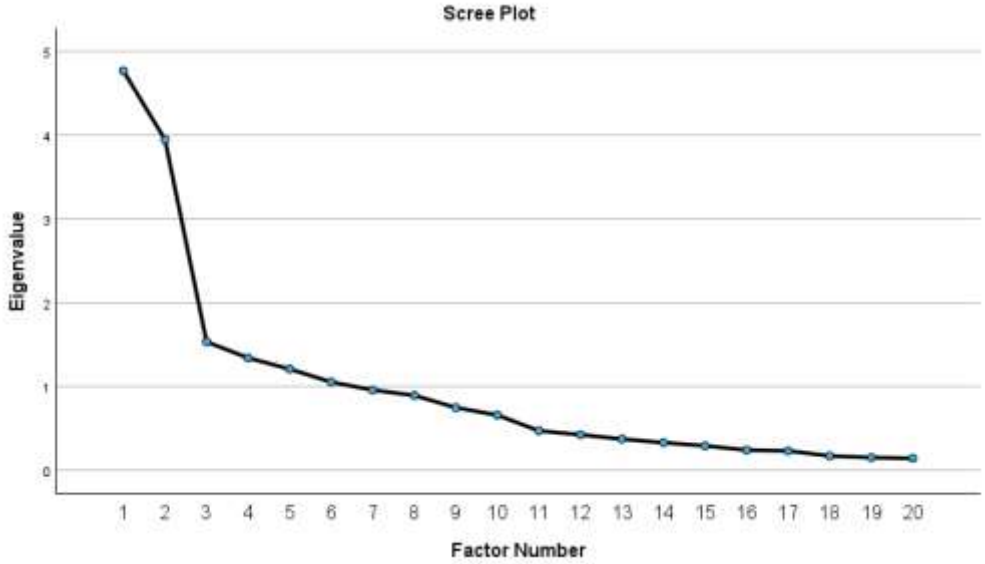

Figure 1: Scree Plot of the exploratory factor analysis of the AHEAD - Emotional Health: Behaviour Subsection

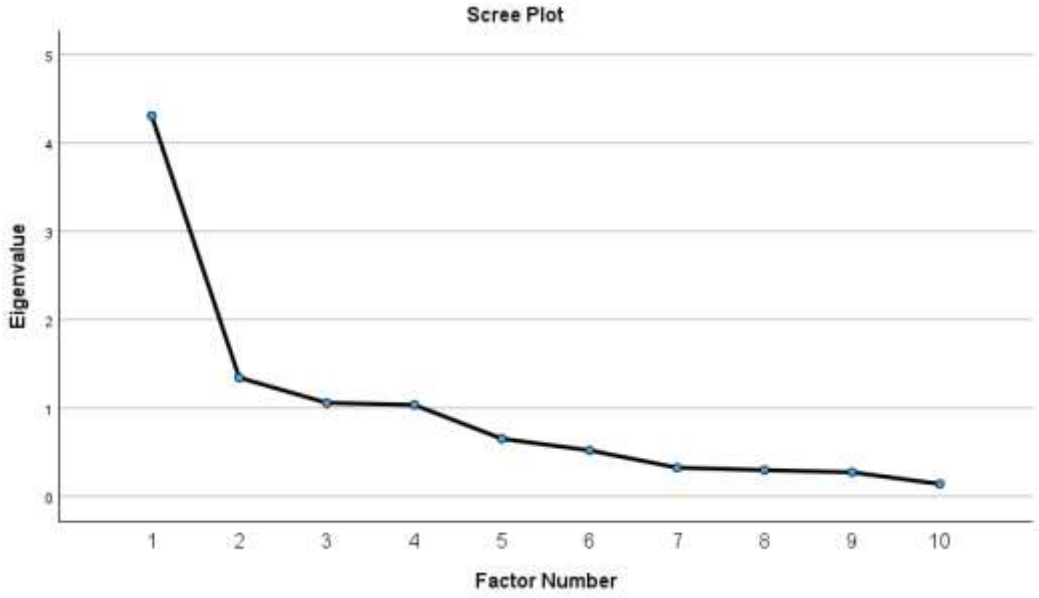

Figure 2: Scree Plot of the exploratory factor analysis of the AHEAD - Emotional Health Module for 1 - 6 years.

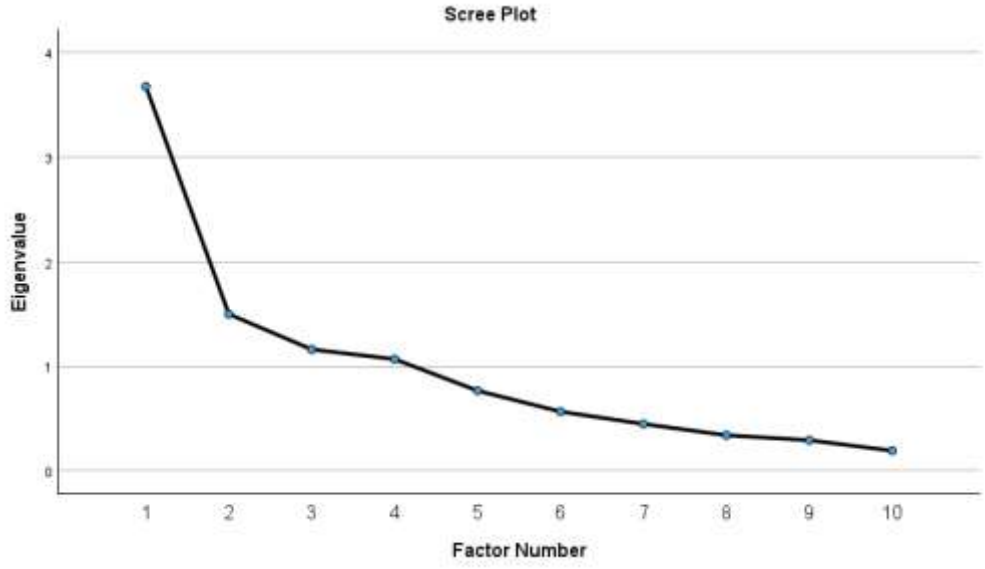

Figure 3: Scree Plot of the exploratory factor analysis of the AHEAD - Emotional Health Module for 6 - 18 years