RESEARCH PAPER

Validation of Developmental Assessment Tool for Anganwadis (DATA)

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Objective: To develop, standardize, and partly validate a developmental scale for toddlers (age, 1.6 to 3 years) attending anganwadis in India.

Methods: After the development of the 12-item Developmental Assessment Tool for Anganwadis (DATA), its internal consistency, face validity, content validity and construct validity were studied in 100 toddlers in anganwadis and were found to be appropriate. A total of 429 toddlers with a mean (SD) age of 30.9(5.2) months from 36 randomly selected anganwadis were recruited for its standardization. Raw scores were converted to standardized T-scores. Scoring pattern for domains and aggregate developmental scores were formulated.

Results: Except for one item in the original scale, all the items were endorsed by parents suggesting a good content validity. Cronbach's α of 0.86 suggested a high internal consistency. Factor analysis replicated the 2-factor structure explaining 56% of variance. An aggregated developmental score based on the standardized T-scores demonstrated that a DATA score between 33 and 28 suggested 'at risk' for developing developmental delays. A score of ≤27 suggested already delayed milestones. A score of 27 to 16 suggested a 'mild delay', a score of 15 to 5 suggested a 'moderate delay' and ≤4 suggested a 'severe delay' in development.

Conclusion: DATA is a brief, simple and psychometrically sound measure for use in anganwadis for identifying toddlers at risk or with developmental delays. Differentially identifying toddlers at risk or with developmental delay helps in referring them for appropriate interventions.

Keywords: *Anganwadi, Child, Developmental Scale, Normative, Validation*

The prevalence of developmental delay in the general population in India is as high as 1.4-2.4%, among children under 3 years of age(1,2). However, the mean age at which these children attend early intervention, that maximizes the child's development, is 4(1.4) years, suggesting that majority of these children are neither identified nor referred early(3). A logical, yet neglected, population for early identification of developmental delays is children attending Anganwadis, the largest Integrated Childhood Development Services (ICDS) in the world, delivering health care to 98 million out of the 160 million children between 2 and 6 years of age in India. Among its beneficiaries, the prevalence of developmental disability is 2.7%(4) and thus is as high as in the general population. Anganwadi workers have been found efficient in identifying children with disabilities at anganwadis(4) and the preschool component of anganwadis has been found effective in improving the cognitive development of children between 3 to 5 years of age(5).

The age of inception of toddlers in to anganwadis being about 2 years, a measure to identify children at risk of developing a developmental delay or with developmental delays at 2 to 3 years will eminently suit the use of anganwadi workers. For the screening

tool to be simple and locally relevant, a norm referenced developmental measure based on the reference values is required. We herein summarize two studies done to achieve this goal. The first study describes the development of the measure, Developmental Assessment Tool for Anganwadis (DATA) and its partial criterion-referenced validation. The second study documents the norm-referenced validation of the measure to identify children with developmental delay for appropriate intervention.

SUBJECTS AND METHODS

Study 1

Conceptualization and nature of the measure: We wanted a brief scale to screen toddlers at risk for developing developmental delays and those who already have developed developmental delays while they attend the primary-care pediatric setting of anganwadis. The differential identification of these two groups of children is needed for organizing appropriate referrals. Also, we wanted the instrument to be validated for toddlers around 2½ years of age. This age threshold was important because of different reasons: (*i*) screening the toddler immediately after contact with anganwadi will increase false-positivity, as many of them might not have been exposed to stimulating environments; and (*ii*) the anganwadi worker is also not familiar with the toddler to make conclusions on ambiguous findings.

Item selection: We began by constructing a list of milestones likely to be important to toddlers at risk or with developmental delay. Items from various available developmental measures namely the Denver Developmental Screening Test (DDST), Developmental Assessment Scale for Indian Infants (DASII), The Receptive–Expressive Emergent Language Test (REEL), Vineland Adaptive Behavior Scale (VABS) were compiled. Additionally, three experts in the field of developmental pediatrics, clinical psychology and child psychiatry ranked the items collected on a 3 point scale where 1 was least important and 3 was most important and thus 24 items were selected.

Item reduction: We followed the concept-retention approach to include the six domains of gross motor, fine motor, cognitive, personal-social, expressive language, and receptive language. Secondly, to maintain the Content validity, items in the domain were based on the endorsement rate of an item, and the impact the item had on the parent as a problem. To decrease the idiosyncratic response to a given question it was decided *a priori* to include two items in each domain. Thirdly, the choice of the two items in each domain was based on the statistical procedures of loading pattern in the factor analysis (with clear loading) and equidiscriminative item-total correlation (items with the highest correlation with the overall score). Thus we selected the 12 items that significantly overlapped in both these statistical procedures.

Endorsement category and response category format: We decided on the dichotomous endorsement category of 'emerged' and 'not emerged' for endorsing a milestone based on fixed criteria for pass (Appendix 1). If the milestone has 'emerged', the age of the development of the milestone in months was noted and for milestones 'not emerged', a score of 0 was given by the anganwadi worker.

Standardization of score and scoring pattern: The development of the milestones recorded in the form of raw scores (means and standard deviations in months) was converted to standardized T-scores, The mean and standard deviation of various milestones that have emerged or not were converted to an equivalent T-score with a mean of 50 and a standard deviation of 10 as shown in the data analysis(6). The definition of 'at risk' for developmental delay and definite delay graded as 'mild delay', 'moderate delay', and 'severe delay' was based on the standard deviations of 1.5, 2, 3 and 4 on the lower side of the normative mean and standard deviation, using the conventional standardization principles(7).

For the scoring pattern, the emerging age in months for any skill was checked at the end of the assessment with a standardized T-score equivalent. The arithmetic average of the items in a domain formed the domain score and the arithmetic average of all the domain scores provided the final Aggregate Developmental Score (ADS).

Sample size and sampling: A list of anganwadis was collected from three geographically different districts in Kerala (Thiruvananthapuran, Kottayam and Kozhikode) and 18 anganwadis from urban and 18 anganwadis from rural areas of these districts were randomly selected. A sample of 100 toddlers were included if they were 1.6 to 3 years of age and accompanied by a parent as the primary caregiver, from the anganwadi area or anganwadi depending on the age.

Data analysis: The internal consistency of the 12 items in the DATA was evaluated with Chronbach's μ. The construct validity of the measure was analyzed using exploratory factor analysis. The Factor structure of DATA was demonstrated by principal components analysis with varimax rotation. Data was analyzed using SPSS software version 16.

Study 2

Setting and sample: The study was conducted at randomly selected anganwadis in the three districts of Kerala (Thiruvananthapuram, Kottayam and Kozhikode), India. Toddlers (*n*=429) between 1.6 to 3 years of age accompanied by a parent were included in to the study from the anganwadi area or anganwadi. This sample size was adequate as a sample size of minimum of 300 participants is required when no other subgroup analysis is considered *a priori*(6).

Data collection: The data was collected independently by six developmental therapists with an average experience of 5.9 (1.2) years in assessing children with developmental delays. They approached the toddlers for data collection after acquiring informed consent from the parent and verbal assent from the aganwadi worker. The study was approved by the institutional review board.

Data analysis: The normative data for the study sample was generated using the mean and the standard deviation. From the standard deviation for the norm, the standard deviations on the lower side was calculated for those at risk for delay and those who already had developmental delay. Thus, a standard deviation of 1.5 (at risk), 2 (mild delay), 3 (moderate delay), 4 (severe delay) from the normative standard deviation was calculated and formed the raw scores. The raw scores were converted to standardized T-scores using the formula: T=50+[10*(raw score-mean)/standard deviation], where raw score is the score for that person on the scale, mean is the mean for that reference norm, and standard deviation is the standard deviation for that reference norm. Arithmetic average was calculated wherever appropriate. Data was analyzed using SPSS software version 12.

RESULTS

In study 1, with the item endorsement for assessing the content validity, one item namely, '*shows understanding of feeling, verbalizing love, anger, sadness and laughter etc*' was not endorsed by more than 90 percent of the parents and was dropped from the measure. Thus, 23 items were available for statistical reduction of items and 12 items as decided before hand with the clear loading to one factor in the factor loading and the highest correlation coefficients in the equidiscriminative item-total correlations were selected (***Table* 1**). In the reliability analysis, the internal consistency of the scale was high with a Chronbach's α value of 0.86.

While we investigated the factor structure of the items in the DATA, the principal component analysis reduced the 12-items to 2 components, an examination of the scree plot and eigen values (of >1) showed a noticeable drop only after the second factor. A loading value of ≥0.5 was considered significant. DATA items 1 (kicks stationary ball), 5 (finds specific object on request), 7 (differentiate between edible and non-edible substances), 8 (proper bowel/bladder control during day time), 9 (combines 2 words to express possession), 10 (does child ask question "What is this?"), and 11 (points to common objects described by its use) loaded on to factor 1 (Cognitive-social-motor-linguistic). DATA items 2 (jumps in place), 3 (folds paper in to half in imitation), 4 (opens stacking barrel and takes out beads self-dislike), and 12 (points to picture of action) loaded on to factor 2 (Motor-linguistic). DATA item (places object in/on/under on request) cross-loaded in to factor 1 and 2, thus were considered not specific to any domain of

TABLE I ITEM REDUCTION FOR DATA

Item	Loading pattern of factors	Equidiscriminative correlation
Gross motor		
Throws ball to an adult 5 feet away	Did not load	0.35
Kicks stationary ball*	Loaded	0.57
Jumps in place*	Loaded	0.69
Balance on one foot	Did not load	0.64
Fine motor		
Build tower of 5 blocks	Did not load	0.59
Holds pencil adaptively	Loaded	0.20
Folds paper in to half in imitation*	Loaded	0.62
Opens stacking barrel and takes out* beads	Loaded	0.50
Cognitive		
Finds specific object on request*	Loaded	0.66
Names 4 common pictures	Did not load	0.71
Places object in/on/under on request*	Loaded	0.69
Matches 3 colors	Loaded	0.56
Personal social		
Differentiate between edible and non-edible substances*	Loaded	0.58
Shows understanding of feelings, verbalizing love, anger, sadness and laughter etc.	Poor endorsement, item deleted	
Proper bowel/bladder control (during day time)*	Loaded	0.62
Puts on simple clothing	Did not load	0.64
Expressive language		
Combine 2 Different words	Loaded	0.70
Combine 2 words to express possession*	Loaded	0.74
Does child ask question "What is this?"*	Loaded	0.73
Uses words to express relationships	Loaded	0.67
Receptive language		
Points to common objects described by its use*	Loaded	0.56
Points to picture of Man/Woman	Loaded	0.41
Points to picture of action*	Loaded	0.63
Points to 8 body parts	Loaded	0.46

**Items selected for the final version of the measure*

developmental disability. Otherwise, all items loaded distinctively and without cross-loadings (***Table* II**). This 2-factor model explained 56% of the variance.

In study-2, 429 toddlers participated in the study and among them 229 were boys and 200 were girls. Most of the children were from the low socio-economic status and were between the chronological ages of 18 to 50 months [mean (sd)=30.9(5.2)]. Most of the skills corresponding to the items in the measure emerged between 31 to 33 months. The normative data for referencing DATA was extrapolated from the mean ages and standard

TABLE II FACTOR STRUCTURE OF THE FINAL VERSION OF 12-ITEM DATA

Item	Cognitive-social-motor-linguistic	Motor-linguistic
Gross motor		
Kicks stationary ball	0.71*	0.10
Jumps in place	0.35	0.67*
Fine motor		
Folds paper in to half in imitation	0.35	0.60*
Opens stacking barrel and takes out beads	0.003	0.73*
Cognitive		
Finds specific object on request	0.73*	0.23
Places object in/on/under on request	0.50	0.51
Personal social		
Differentiate between edible and non-edible substances	0.73*	0.12
Proper bowel/bladder control (during day time)	0.75*	0.16
Expressive language		
Combine 2 words to express possession	0.85*	0.19
Does child ask question "What is this?"	0.76*	0.29
Receptive language		
Points to common objects described by its use	0.53*	0.27
Points to picture of action	0.13	0.74*

** Principal component analysis. Rotation method: Varimax with Kaiser normalization; * loadings > 0.50*

deviations at which the milestones emerged and are summarized in ***Table* III**. These raw scores converted to standard T-scores are presented in ***Table* IV**. The scoring key based on the standardized score to identify toddlers at risk for developing development delay and those who showed developmental delays are summarized in ***Table* V**.

DISCUSSION

This short, simple to use and psychometrically sound measure based on the developmental norms of the anganwadi children, offers anganwadi workers a more efficient way of identifying toddlers at risk and with developmental disabilities shortly after they join anganwadis, as conceptualized.

The face validity of the measure is high as the items in the measure were compiled from various internationally used measures to rate developmental delays. Except one item in the initial version of the scale (*shows understanding of feeling, verbalizing love, anger, sadness and laughter etc*) none of the items was assigned a score of 0 by more than 90% of the parents in this study, suggesting that the items were appropriate for measuring the development of a toddler, reflecting the endorsement of the content validity.

For item reduction we used statistical procedures that effectively selected the most representative of the items in each domain. Using these techniques we reduced the 23 items to the most representative 12 items. The factor loading principle looked at items without cross-loading or no loading and only items with clear loading on to a specific factor improved the specificity of items in identifying symptoms in a specific domain. The equidiscriminative item-total correlations clearly discriminated those items that contributed to the overall content of the measure. These statistical procedures have been used effectively in addition to the concept-retention approach for item reduction in the psychometric

TABLE III NORMATIVE DATA ON MILESTONES OF 2-3 YEARS OLD CHILDREN AND EXTRAPOLATED DELAYS BASED ON THE STANDARD DEVIATIONS*#

Item	Normal development	At risk	Mild delay	Moderate delay	Severe Delay
Grossmotor					
Kicks stationary ball	31.3(4.9)	39	41	46	51
Jumps in place	32.9(3.9)	39	43	47	51
Fine motor					
Folds paper in to half in imitation	32.2(4.4)	39	41	45	50
Opens stacking barrel and takes out beads	32.2(4.8)	39	42	47	51
Cognitive					
Finds specific object on request	31.6(4.6)	39	41	45	50
Places object in/on/under on request	32.2(4.3)	39	41	45	49
Personal social					
Differentiate between edible and non-edible substances	31.4(4.8)	39	41	46	51
Proper bowel/bladder control (during day time)	31.7(4.5)	39	41	45	50
Expressive language					
Combine 2 words to express possession	31.6(4.6)	39	41	45	50
Does child ask question "What is this?"	31.9(4.4)	39	41	45	50
Receptive language					
Points to common objects described by its use	31.5(4.9)	39	41	46	51
Points to picture of action.	33.0(4.2)	38	41	46	50

** All figures in months adjusted for the decimal; # At risk= 1.5 SD; Mild delay=2 SD; Moderate delay = 3 SD; Severe delay =4 SD*

validation of instruments(8). The factor structure demonstrated a 2-factor model and there are no previous data to compare our study.

Although the items of DATA were aimed at children from 2-3 years, the age range of the population we recruited was from 18-50 months as we wanted to cover the 4SD deviation in developmental range on both directions for the standardization procedure. The normative data on the age of emergence of various skills among the toddlers at anganwadis ranged from 31 to 33 month in this study. There is a slight overall delay among the anganwadi population than that is described in the literature [mean (SD)=27(4.6)] months for all the 12-items when compared with the original validation data of the measures conducted in high income countries. This could be explained by the low socio-economic status of the toddlers from rural background attending anganwadis. Over the past decades, toddlers from low socioeconomic background have been repeatedly shown to have delay in development and later low scores in formal intelligence tests because of malnutrition and poor environmental stimulation(9-11).

The norms for DATA items were based on a simple linear transformation of the raw data to indicate the level of delay in development. As ***Table*** **III** shows, this yielded similar, but slightly different means and standard deviations for each domain. Therefore, if the extrapolated raw scores were considered equivalent and compared for domain scores within DATA or with other similar international measures it would result in interpretation errors. In our study, especially where the scores were close to the mean, this error was minimal and the error was exaggerated as scores

TABLE IV CONVERSION OF RAW SCORE TO STANDARDIZED SCORES FOR DATA BASED ON T SCORES*

Item	At risk	Mild delay	Moderate delay	Severe delay
Grossmotor				
Kicks stationary ball	30	25	12.5	0
Jumps in place	33.3	26.6	13.3	0
Fine motor				
Folds paper in to half in imitation	32.5	27.5	17.5	5
Opens stacking barrel and takes out beads	32.5	25	12.5	2.5
Cognitive				
Finds specific object on request	32.5	27.5	15	5
Places object in/on/under on request	32.5	27.5	17.5	7.5
Personal social				
Differentiate between edible and non-edible substances	32.5	25	15	2.5
Proper bowel/bladder control (during day time)	32.5	27.5	17.5	5
Expressive language				
Combine 2 words to express possession	32.5	27.5	15	5
Does child ask question "What is this?"	35	30	17.5	7.5
Receptive language				
Points to common objects described by its use	32.5	25	12.5	0
Points to picture of action	35	27.5	17.5	7.5

**1SD delay in months in achieving a specific milestone is equivalent to 1SD in the T score*

TABLE V SCORING KEY FOR DATA*

Delay in specific domains#	Domains in DATA						Total
	Gross motor	Fine motor	Cognitive	Personal social	Receptive language	Expressive language	severity of delay as in ICD-10†
At risk	32	33	33	33	34	34	33-28
Mild delay	26	26	28	26	28	26	27-16
Moderate delay	13	15	16	16	16	15	15-5
Severe delay	0	4	6	4	6	4	≤4

** All scores adjusted for decimals; # Specific domain scores are based on the arithmetic average of the scores for the 2 items in that domain; † Total scores are based on the arithmetic average for all the 6 domains and compared with ICD 10 categorical classification*

moved away from the mean. Consequently, statistical adjustments were needed to ensure an informed comparison of scores between individual DATA domains and between various international measures of development. In our study, to overcome this, we have calculated an exact standard score equivalent using the T-score principles (with a mean of 50 and SD 10) to enable comparisons within domains and a final Aggregate Developmental Score. Further standardizing the scores using the principle of deviation IQ will also allow the scores to be comparable with the internally used measures and will be done in future studies as noted in the literature(12). Thus, ***Table* IV** summarizing the

WHAT THIS STUDY ADDS?

- DATA is short, psychometrically strong, norm-referenced developmental scale to identify toddrers at risk for developmental delays and differentiate toddlers with various levels of developmental delays.

conversion details of standard deviations to T-scores gives a simple correction to potential interpretation error based on the traditionally derived standard deviation based developmental scores. An aggregate developmental score of ≤33 indicate the child at risk and requires referral for appropriate therapy at the preschool component of anganwadis. Preschool component of anganwadis has been found effective in improving the cognitive development among toddlers and young children. However, a dose-response relationship between the number of sessions attended by the child and the cognitive enhancement in the child has gained has not been elucidated and needs further exploration(5). Those toddlers and children with an Aggregate Developmental Score (ADS) of ≤28 need referral for specialized interventions like special education, speech therapy, behavioral techniques and speech therapy (***Table* V**).

This measure has the advantage of differentiating the toddlers at risk for developing delays from those who already have mild to severe delays. This differentiation is important as toddlers at risk can be stimulated at the preschool component of anganwadis itself, whereas children with proved delays need to be referred for appropriate early interventions(13). Further, training and capacity building of the anganwadi workers can be based on a one day participatory workshop model reported previously to be effective(14), with five simple modules to sensitize them to developmental delays, the basics of normal developmental milestones, make observations about milestones in a few children from their anganwadi area, practice the DATA and finally evaluate their identification ability by comparing their DATA result with the trainer. The pre-field trial version of DATA, the assessment materials required and the assessment procedures and scoring pattern are presented in ***Appendix* 1.**

The limitations of the standardization are that subgroup analysis, like effect of gender, on the emergence of milestones was not done. The measure was administered by experienced developmental therapists, as against the intended utility by anganwadi workers. It should be remembered that these data are from pre-field trial study and hence these limitations will be addressed during the field trials of DATA.

In conclusion, DATA is a short, psychometrically strong, norm-referenced developmental scale with partial criterion referencing to identify toddlers at anganwadi who are at risk for developing developmental delays, and differentiate those who already have developed delays at 2½ years for appropriate interventions. In addition, we recommend that regular developmental assessments be conducted on the beneficiaries of anganwadis, every year, at three more key ages of 3½, 4½ and 5½ years to institute early intervention when required. In future, scales appropriate for these ages should be developed, standardized and validated across the country for the benefit of the anganwadi children.

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Appendix 1: THE PRE-FIELD TRIAL VERSION OF DATA

DATA assessment and interpretation			Scoring		
Item	Materials	Method	Criteria for pass	Emerged	Not emerged
Gross motor development					
Kick large stationary ball	Large plastic ball	Ask the child to kick the ball placed in front of the child	Without any physical support, the child should kick the ball at 30 months		
Jumps in place with both feet	Jumps in place	Demonstrate how to jump in place with both feet together. Ask the child to imitate	The child jumps in place by raising both feet together off the ground at 33.3 months		
Fine Motor Development					
Folds paper into half in imitation	Square Paper (15 cm)	Demonstrate paper folding. Give another square paper to the child and ask him to fold it into half	Child folds the paper into half (need not be exact half) 32.5 months		
Open the stacking barrel (without grooves) and take out the beads	Container without grooves	Offer the box/ container containing the object to the child .Ask the child to open the box, take out the object and close it	Child opens and close the box properly at 32.5 months		
Cognitive development					
Find specific object on request	Miniature car, brush, spoon, comb, doll	Ask the child to take an object that the tester names from among the others	Child picks up at least 3 objects correctly when named 32.5 months		
Place object in, on and under upon request	cup, bead	Ask the child to place the bead on the table, under the table & in the cup	Child places the bead correctly as per the tester's request 32.5 months		
Personal social development					
Differentiate between edible and non-edible substances	–	Obtain parents' report	Child differentiates edible and non-edible substances at 32.5 months		
Proper bowel/bladder control (during day time)	–	Obtain parents' report	Child is able to keep dry during day time at 32.5 months		
Expressive language development					
Combines two words to express possession	Picture of shirt-pant, churidhar	Show the picture and ask the child to identify the users	Child is able to say daddy's shirt, mummy's churidhar at 32.5 months		
Child ask question 'what is this?'	–	Observe the child during the session/Obtain parents' report	Child asks question 'What is this?' at 35 months		
Receptive language development					
Points to common objects described by its use	Miniature car, spoon,cup, comb, brush	Describe the use of each item. Ask the child to point out the item when the use of each is described	Child points to at least 4 objects correctly at 32.5 months		
Points to pictures of action	Pictures describing action	Show the pictures displaying particular action to the child and encourage the child to identify the activity shown	Child able to point out 3 action pictures correctly (writing, running, eating) at 35 months		

Instructions: Give the child the appropriate task with appropriate test materials. Parent's report can be also collected to enhance your observations. Score based on the pass criteria. After completion add all the scores in months and divide by 12. This gives the aggregate developmental score (ADS). Any child with an ADS of ≤33 months needs referral to intervention at preschool component of anganwadi and ADS of ≤28 needs specialized intervention referral. Developmental score = _____ months. Assessed on _____.