

Designing and Validation of a Hindi-language Parent Self-report Developmental Screening Tool

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Aim: To design and validate Hindi-language parent self-report developmental screening questionnaires for 9-month and 18-month-old Indian children.

Design: Cross-sectional study

Setting: Tertiary-care pediatric hospital from April 2014 to March 2016

Participants: In each age group (9-month and 18-month), 45 children were enrolled for designing of questionnaires (30 for obtaining parental observations of current development and 15 for pre-testing). For validation of tool, 100 children (60 low risk and 40 high risk) were enrolled in each age group.

Methods: For designing, observations regarding current developmental milestones were obtained from parents and a list of all enumerated milestones was prepared. After detailed discussion by a team of developmental pediatricians, pediatric resident, clinical psychologist and language specialist, milestones were chosen for drafting of questionnaires. In each age group,

drafts were pre-tested and required modifications were done. The final questionnaires contained 20 items each to be scored on a Likert scale (total score ranging from 20 to 60, a lower score indicating a higher risk of developmental delay). These questionnaires were validated against Developmental Assessment Scale for Indian Infants (DASII), a gold standard instrument.

Results: On ROC analysis, the 9-month and 18-month screening tool had area under curve of 0.988 and 0.953, respectively, for detecting developmental delay. Score ≤ 50 on the 9-months questionnaire had sensitivity of 100% and specificity of 87.2%. Score ≤ 49 on the 18-months questionnaire had sensitivity of 91.4% and specificity of 88.7%.

Conclusions: The new questionnaires have a promising role in developmental screening of children at the time of routine immunizations in our country.

Keywords: *Diagnosis, Early intervention, Identification, Indigenous.*

Developmental delay is seen in upto 3% of children younger than 5 years [1]. Early detection, followed by early intervention have a positive impact on cognitive and motor outcomes, in addition to enabling the families to better understand and cope up with the condition [2-6]. Early detection relies on continuing developmental surveillance and periodic developmental screening by primary care physicians; however, these are infrequently practiced. One of the major reasons behind under-utilization of developmental screening tools is time-constraint, as most of the tools require elicitation of the child's skills and are cumbersome to use [7,8].

To overcome the shortcomings of traditional screening tools, some parent-report tools have been developed, supported by research that showed that parents can provide accurate information about their child's development. Large number of studies have subsequently confirmed that these tools are reliable and

valid [9]. The available Western tools developed in other countries can be translated in Indian languages for use, but many of their items are culturally inappropriate, and most of these tools are expensive to use. This study was planned to design and validate simple, inexpensive, indigenous Hindi language parent self-report developmental screening tool for 9- and 18-month-old children, that can be completed during routine visits for vaccination.

METHODS

This study was conducted at Chacha Nehru Bal Chikitsalaya, a pediatric tertiary-care institute in northern India from April 2014 to March 2016. The study protocol was approved by the Institutional Ethical Committee of Maulana Azad Medical College. The study had two phases, the first was designing of screening questionnaires and second being validation of questionnaires (**Fig 1**).

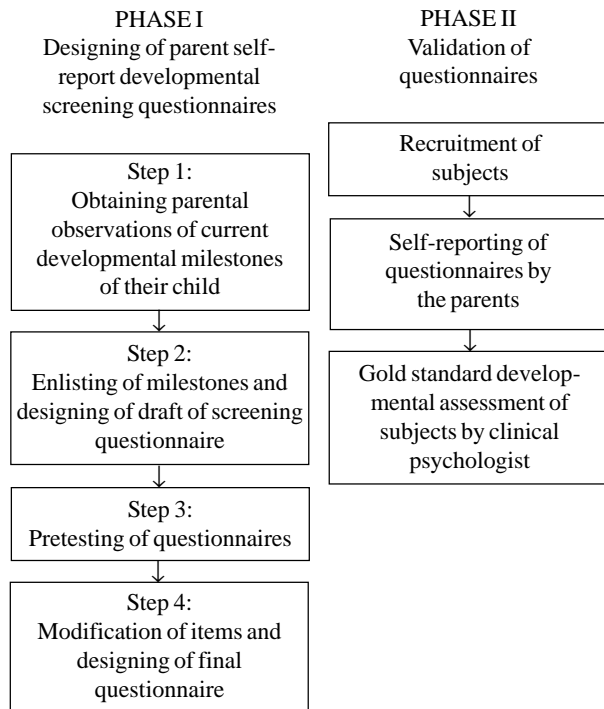


FIG. 1 Flow chart of the study procedure.

Phase 1: Designing of the Parent-report Developmental Screening Questionnaires

Phase 1 of the study consisted of four steps. In the first step, observations regarding the current developmental milestones were obtained from a convenience sample of parents of 30 children each in the age group of 9-month to 9-month-14-days and 18-month to 18-month-29-days, recruited from the immunization room of pediatric OPD (10 each from upper, middle and lower socioeconomic strata) [10]. The inclusion criteria were that the available parent should have primary education, is living with the child, and the primary language of communication is Hindi. The exclusion criteria were children with history of prematurity, low birth weight, perinatal asphyxia, bilirubin encephalopathy, meningitis/encephalitis and NICU stay > 4 days, known dysmorphic syndrome or chromosomal anomaly, chronic systemic illness, and severe acute malnutrition. Children were screened for enrollment by a pediatric resident. After obtaining informed consent, parents were invited to a quiet room. In the presence of a developmental pediatrician and a pediatric resident, parents were requested to provide a detailed account of the development milestones currently achieved by their child (the activities that their child is currently doing), in their own words in Hindi language. To elicit milestones in all the developmental domains, some clues pertaining to the domains of development were provided that were

missed by the parents *i.e.* they were asked about activities that the child can do with his/her hands, what does he speak etc. The responses were recorded in Hindi language.

In the second step, a list of all the milestones enumerated by the parents was prepared in Hindi language along with their frequency. The different sentences/words used to describe the same milestone by the parents were also listed below the respective milestone. A meeting consisting of the investigators (2 developmental pediatricians, a clinical psychologist and a pediatric resident) and a language specialist was called and all the enumerated milestones were discussed in details. In each age group, milestones were chosen (by consensus decision-making based on simple majority) taking into consideration the appropriateness and frequency of enumeration by the parents. The simplest language with reading level of 5th-grade or less was chosen. Each milestone was converted into a question by prefixing Hindi translation of 'Does your child' to the milestone *i.e.* the milestone 'Understands being scolded' was converted to 'Does your child understand being scolded?'. Thus initial draft of the screening questionnaires was designed for each age group. Each item was to be scored on a Likert scale of 1-3 (1-activity has never been observed, 2-activity is sometimes observed or performed with difficulty, 3-activity is frequently observed and easily performed), with a lower score indicating a higher risk of developmental delay.

In the third step, each questionnaire was pre-tested in parents of 15 children. The inclusion and exclusion criteria were same as that of the first step. Each parent was requested to grade the understandability and relevance of each question on the scale of 1-3 (for understandability, 1-difficult to understand, 2-some difficulty in understanding, 3-easy to understand; for relevance, 1- not relevant to my child, 2-some relevance, 3-highly relevant)

In the fourth step, a meeting consisting of investigators and language specialist was reconvened. All the items rated to be difficult to understand or irrelevant were modified, replaced or discarded and the final screening questionnaires were designed.

Phase 2: Validation of the Questionnaire

Validation was done using Developmental Assessment Scale for Indian Infants (DASII), a gold standard instrument [11]. A convenience sample of 200 children were enrolled (100 each in the age group of 9-month to 9-month-14-days and 18-month to 18-month-29-days). In each group, sixty children were recruited consecutively

from immunization room of pediatric outpatient department (referred to as low risk group) and 40 were recruited consecutively from the follow-ups of high risk neonatal clinic and new cases referred to child development clinic (referred to as high risk group). The inclusion criteria were that one of the available parents has completed primary education, is able to read Hindi language and had been living with the child. The exclusion criteria were history of prematurity, acute severe illness and previous diagnosis of developmental disorder.

Children were screened for enrollment by a pediatric resident. After obtaining informed consent, a detailed clinical evaluation was done. The questionnaire was given to the parents for self-reporting and scored by a pediatric resident involved in the study. Developmental quotient (DQ) of the child was assessed using Development Assessment Scale for Indian Infants (DASII) by a clinical psychologist, preferably on the same day or within next 1 week. The clinical psychologist was blinded to the scores of the questionnaire.

DASII consists of a mental and motor scale and provides a corresponding DQ score. A DQ score ≤ 70 ($\leq 2SD$) in either scale is considered as failure (developmental delay). In this study, another criteria was also used for defining developmental delay; DQ score ≤ 85 ($\leq 1SD$) in either scale. This group included children with mild/borderline developmental delay who might also benefit from early intervention. Parents of children who failed on DASII were counseled and early intervention services were offered.

Statistical analysis: The data was analyzed using SPSS version 16 and STATA version 12. The results of screening questionnaires were obtained as continuous variables between 20 to 60. The results of DASII was in form of pass or fail. Receiver operating characteristic (ROC) analysis was done for validation of questionnaires and defining appropriate cut-off values on the questionnaires to classify screen positives. Area under curve (AUC) was used as the measure of validity. Various coordinate points on ROC curve were studied and optimal cut-off values on the tool was identified, keeping in consideration that the cut-off value should yield high sensitivity with reasonable specificity. Psychometric properties of the tool (sensitivity, specificity and positive and negative predictive values) at the identified cut-off values were reported.

RESULTS

In the designing phase, in 9-months and 18-month age group, 28 and 26 milestones, respectively were

enumerated by five or more parents. Twenty milestones were chosen in 9-month age group and 21 in 18-months age group, for designing the initial draft of questionnaire. On pretesting, 4 and 5 items, were rated as difficult to understand/irrelevant in the 9- and 18-month questionnaires, respectively. They were modified, replaced or discarded. The final questionnaires consisted of 20 items for each age group.

For validation, the questionnaires were given to parents of 100 children in each age group for self-reporting. It took around 10 minutes for parents to complete the questionnaire. The socio-demographic and other characteristics of participants are shown in **Webtable I. Table I** shows the results of DASII evaluation in the study subjects.

Using DASII score ≤ 70 to define developmental delay, the 9-month questionnaire had an AUC of 0.988 (95% CI 0.972-1.004), (**Fig. 2**). In high-risk and low-risk group, the AUC was 0.977 (95% CI 0.943-1.012) and 1.000, respectively. Using DASII score ≤ 85 to define developmental delay, the AUC was 0.948 (95% CI 0.898-0.998). In high risk and low risk group, AUC was 0.909 (95% CI 0.820-0.998) and 0.987 (95% CI 0.959-1.014), respectively.

The 18-month questionnaire had an AUC of 0.953 (95% CI 0.914 to 0.992), using DASII score ≤ 70 to define developmental delay (**Fig. 2**). In high-risk and low-risk group, the AUC was 0.901 (95% CI 0.749-1.054) and 0.924 (95% CI 0.843 to 1.005), respectively. Using DASII score ≤ 85 to define developmental delay, the AUC was 0.939 (95% CI 0.889-0.989). In high-risk and low-risk group, AUC was 0.846 (95% CI 0.652-1.040) and 0.943 (95% CI 0.879-1.007), respectively.

On 9-month and 18-month questionnaire score ≤ 50 and score ≤ 49 , respectively were suggested as appropriate cut-off for detecting developmental delay (DQ ≤ 70). For detecting developmental delay along with

TABLE I RESULT OF DASII IN THE STUDY POPULATION (N=100)

DASII results	Low risk group (n=60)	High risk group (n=40)	Total
<i>9-month group</i>			
Score ≤ 70	3 (5)	19 (47.5)	22 (22)
Score ≤ 85	7 (11.7)	23 (57.5)	30 (30)
<i>18-month group</i>			
Score ≤ 70	4 (6.6)	31 (77.5)	35 (35)
Score ≤ 85	6 (10)	32 (80)	38 (38)

Values in n (%), DASII: Developmental assessment scale for Indian infants.

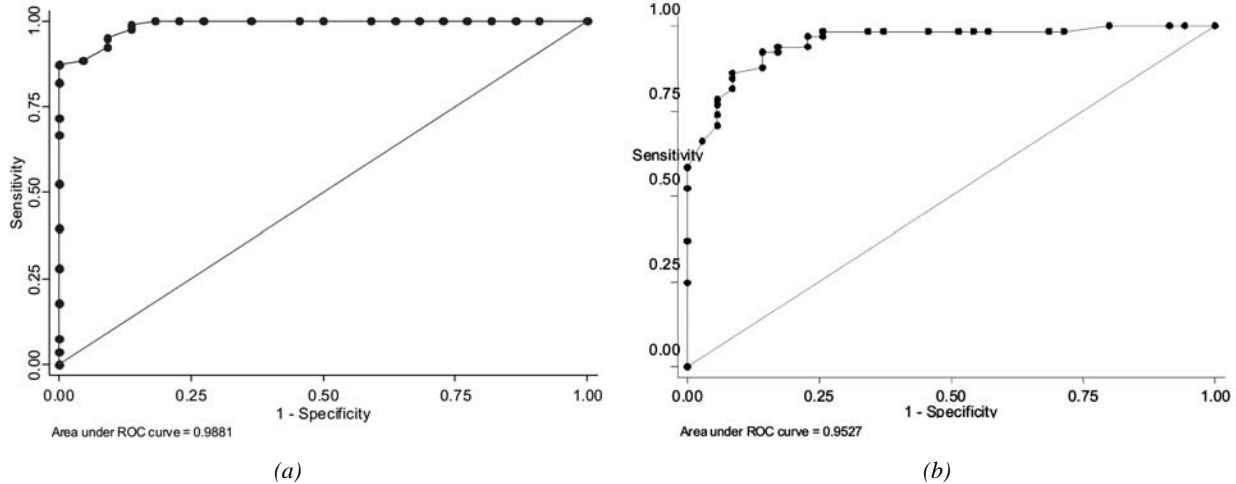


Fig. 2 ROC analysis of recruited 9-month (a) and 18-month children (b), using DASII score ≤ 70 to define developmental delay.

mild/borderline developmental delay ($DQ \leq 85$), score ≤ 52 was suggested as appropriate cut-off on both the questionnaires. The psychometric properties of the questionnaires at the suggested cut-offs are shown in **Table II** and **Table III**.

DISCUSSION

These Hindi language parent self-report questionnaires, labelled New Delhi – Development Screening Questionnaire (ND-DSQ), are free to use, besides being highly valid. Conventionally, a new screening tool is designed by selecting items from existing screening or diagnostic tools; however, in this study the items were chosen from the parental observations of the representative population making it an ideal self-report tool. This tool tapped some new milestones, which are probably pertinent only to the Indian population. With twenty items directed towards a single age-level, it is a

comprehensive tool. It can be reported by parents while waiting for immunizations. They can also be administered *via* email or through a computer-based program. For parents who cannot read, the questionnaires can be administered by a health worker or family member. Overall, these questionnaires appear to have a promising role in developmental screening in our country.

The major limitations of this study were the small sample size for designing and validation of questionnaires. Moreover these questionnaires were applicable to narrow age ranges. In our setting, as many children present late for immunization, the screening questionnaires should be applicable to a wide age-ranges and ideally should exist for all possible age-ranges.

The conventional Indian screening tools like Trivandrum Development Screening Chart (TDST), and Baroda Development Screening Test (BDCT) have only

TABLE II TEST CHARACTERISTICS OF SCREENING QUESTIONNAIRE FOR DETECTING DEVELOPMENTAL DELAY*

	Sensitivity (%)	Specificity (%)	Positive predictive value (%)	Negative predictive value (%)
<i>9-months questionnaire, at cut off score of ≤ 50</i>				
Overall	100	87.2	68.8	100
High risk group	100	81	82.6	100
Low risk group	100	89.5	33.3	100
<i>18-months questionnaire, at cut off score of ≤ 49</i>				
Overall	91.4	88.7	80.0	95.4
High risk group	93.5	77.8	93.5	77.8
Low risk group	75	90.3	33.33	98.2

*Developmental delay defined as DAS II Score < 70 .

TABLE III TEST CHARACTERISTICS OF SCREENING QUESTIONNAIRE FOR DETECTING DEVELOPMENTAL DELAY*

	<i>Sensitivity (%)</i>	<i>Specificity (%)</i>	<i>Positive predictive value (%)</i>	<i>Negative predictive value (%)</i>
<i>9-month questionnaire at cut off score of ≤52</i>				
Overall	93.3	77.1	63.6	96.4
High risk group	91.3	64.7	77.8	84.6
Low risk group	100	81.1	41.2	100
<i>18-month questionnaire at cut off score of <52</i>				
Overall	92.1	80.6	71.6	93.9
High risk group	87.9	71.4	86.8	70
Low risk group	100	81.5	100	80.6

*Developmental delay defined as DASII score <85.

moderate sensitivities and specificities, and require a trained health-worker for administration [12]. INCLEN Neurodevelopmental Screening Test is a new addition to these tools; however, it's a broad screener tool for multiple type of disabilities and is applicable for 2-9 old children only [13]. Recently, a 27-item parent report tool was developed at Lucknow for infants aged 6-24 months. The sensitivity and specificity were 95.9% and 73.1%, respectively [14].

Ages and Stages Questionnaire (ASQ) is the most widely studied parent report tool in the West. It consists of 19 questionnaires (30-items each) spanning the age of 4-60 months, with an overall sensitivity of 75% and specificity of 86% [15]. ASQ has been studied in high-risk populations like follow-ups of hypoxic ischemic encephalopathy and prematurity, with good results [16,17]. It has been also found useful for detecting mild/borderline developmental delays [16,18,19]. Parent's Evaluation of Development Status (PEDS) is another parent report tool available in English language [20]. It is applicable from birth to eight years of age. A study on PEDS from Indonesia on 170 infants aged 3-12 months, showed sensitivity of 83.9%, and specificity of 81.3% [21]. In an Indian study, PEDS was used to screen children aged 24-60 months, the sensitivity was 75% and specificity was 74% [22]. As compared to these tools, the present tool has better psychometric properties.

To conclude, these Hindi parent self-report questionnaires have a promising role in developmental screening in our country. Further studies are required to assess the properties of this tool when used for wider age ranges, including community-based studies. Further, similar questionnaires need to be developed for all possible age ranges, to implement a comprehensive developmental screening program. These questionnaires may be a useful adjunct to the recently launched

Rashtriya Bal Swasthya Karyakram (RBSK), a child health screening and early intervention program under National health mission [23].

Contributors: RJ: conceptualized the study. All the authors were involved in designing the study. AA: collected the data for 9-months age group and RA collected the data for 18-months age group; RJ, AA, RA, SM and MM: were involved in designing of screening questionnaires; SM: did the gold standard developmental assessment; RJ, AA and RA: drafted the manuscript; RJ, MM and MJ: revised the manuscript for important intellectual contents. The final manuscript was approved by all authors. All authors will be accountable for all aspects of the work.

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WHAT IS ALREADY KNOWN?

- Parental reports developmental screening tools are reliable and valid.

WHAT THIS STUDY ADDS?

- New parent self-report developmental screening tool has been designed in Hindi language and validated for use in 9-month and 18-month-old children.

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WEB TABLE I SOCIO DEMOGRAPHIC DETAILS, NEONATAL RISK FACTORS AND CO-MORBIDITIES OF PARTICIPANTS IN VALIDATION-PHASE OF THE STUDY

Characteristics	9-month group			18-month group		
	Low risk group (n=60)	High risk group (n=40)	Total (n=100)	Low risk group (n=60)	High risk group (n=40)	Total (n=100)
<i>Maternal education</i>						
Illiterate	1 (1.7)	0 (0)	1 (1)	1 (1)	0 (0)	1 (1)
Primary	15 (25)	21 (52.5)	36 (36)	11 (18.3)	24 (60)	35 (35)
Secondary/Senior secondary	16 (26.7)	5 (12.5)	21 (21)	16 (26.6)	2 (5)	18 (18)
Graduate & Post-graduate	28 (46.7)	14 (35)	42 (42)	32 (53.3)	14 (35)	46 (46)
<i>Paternal education</i>						
Illiterate	3 (5)	3 (7.5)	6 (6)	1 (1.7)	5 (12.5)	6 (6)
Primary	6 (10)	13 (32.5)	19 (19)	8 (13.33)	11 (27.5)	19 (19)
Secondary/Senior secondary	24 (40)	11 (27.5)	35 (35)	22 (36.67)	8 (20)	30 (30)
Graduate & Post graduate	27 (45)	13 (32.5)	40 (40)	29 (48.33)	16 (40)	45 (45)
<i>Socio economic status</i>						
Upper (upper and upper middle)	19 (31.7)	8 (20)	27 (27)	2 (35)	10	31 (31)
Middle	26 (43.3)	18 (45)	44 (44)	26 (43.3)	18 (45)	44 (44)
Lower	15 (25)	14 (35)	29 (29)	13 (21.6)	12 (30)	25 (25)
<i>Neonatal risk factors</i>						
Neonatal ICU stay >4 days	1 (1.7)	33 (83)	34 (34)	1 (1.7)	28 (70)	29 (29)
Seizures	1 (1.7)	12 (30)	13 (13)	1 (1)	10 (25)	11 (11)
Hypoglycemia	0 (0)	1 (2.5)	1 (1)	0 (0)	1 (2.5)	1 (1)
Hyperbilirubinemia	1 (1.7)	10 (25)	11 (11)	1 (1.7)	10 (25)	11 (11)
Sepsis/ Meningitis	1 (1.7)	13 (32)	14 (14)	0 (0.0)	07 (17.5)	07 (07)
Hypoxic Ischemic Encephalopathy	0 (0)	12 (30)	12 (12)	0 (0.0)	11 (27.5)	11 (11)
<i>Co-morbidities</i>						
Cerebral palsy	0 (0)	7 (17.5)	7 (7)	0 (0)	19 (47.5)	19 (19)
Hearing impairment	1 (1.7)	9 (22.5)	10 (10)	0 (0)	2 (5.0)	02 (02)
Visual impairment	2 (3.3)	8 (20)	10 (10)	1 (1.7)	4 (10.0)	5 (5.0)
Seizures	0 (0)	0 (0)	0 (0)	0 (0)	8 (20.0)	8 (20)

All values in n (%).