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Validation of a Rapid Neurodevelopmental Assessment tool for 10 to 16 year-old young adolescents in Bangladesh

Running Title: Validation of a rapid neurodevelopmental assessment tool

Short title: Neurodevelopmental assessment of young adolescents

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Abbreviations: FSIQ, Full Scale Intelligence Quotient; GDA, General Developmental
Assessment; ICF, International Classification of Functioning; IQ, intelligence quotient; NDI,
neurodevelopmental impairment; PIQ, Performance Intelligence Quotient; PSQ, Processing
Speed Quotient; RNDA, Rapid Neurodevelopmental Assessment; WISC-R Wechsler
Intelligence Scale for Children, Revised ; VIQ, Verbal Intelligence Quotient;

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ABSTRACT

Objective: To validate a Rapid Neurodevelopmental Assessment (RNDA) tool for use by child health professionals to determine neurodevelopmental impairments (NDIs) in young adolescents aged 10-16 years in Bangladesh.

Study design: In a convenience sample of community children (n=47), inter-rater reliability was determined between four testers, and concurrent validity was determined by simultaneous administration of an IQ test (Wechsler Intelligence Scales for Children, Revised, WISC,R) by a child psychologist.

Results: Inter-rater reliability was excellent between the testers on the 47 children administered the RNDA (kappa=1.00). Significantly lower IQ scores were obtained in those identified with 'any (≥ 1) NDI' (n=34) compared to those with no NDI (n=13) on Verbal IQ (p-value <0.0001), Performance IQ (p-value <0.0001) and Full Scale IQ (p-value <0.0001) scores on the WISC,R.

Conclusion: The RNDA shows promise as a tool for use by child health professionals for identifying NDIs in young adolescents aged 10-16 years. A larger study sample is needed to determine its usefulness for identification of some impairments not found in the study population, ie, gross motor, fine motor, hearing and seizures.

INTRODUCTION

In Bangladesh the proportion of young adolescents aged 10-16 years with neurodevelopmental impairments and disabilities is not known. However, in a country where almost 90% enroll into primary schools (UNICEF, 2015), less than half enroll subsequently into secondary schools, and among these, one-fourth drop-out (Ahmed, 2014). These figures indicate that a significant proportion of older children and adolescents fall outside the educational system, remaining marginalized in society. There is no record of these children's underlying neurodevelopmental status, which could provide directions for appropriate interventions to keep them in school.

In acknowledgment that impairments (i.e., temporary functional limitation) and disabilities (i.e., permanent functional limitation) exist in a continuum as defined by the International Classification of Functioning (ICF) of the World Health Organization (WHO, 2001), there is a need to identify specific neurodevelopmental impairments (NDIs) in at-risk children in order to most effectively prevent or ameliorate progression to disabilities. Based on this concept, we have reported the validation of simplified tools for use by non-specialist health professionals in younger children, i.e., ages 0 to <2 years (Khan et al, 2010), 2 to <5 years (Khan et al, 2013) and 5-9 years (Khan et al, 2014). The objective of this study was to validate a Rapid Neurodevelopmental Assessment (RNDA) tool for use with young adolescents aged 10-16 years by child health professionals to identify NDIs.

METHODS

Rapid Neurodevelopmental Assessment (RNDA)

The RNDA tool is a structured procedure for directly assessing children in the following neurodevelopmental domains: gross motor, fine motor, vision, hearing, expressive language,

cognition, behaviour, self-care and unprovoked seizures (Appendix 1). Administration of the RNDA requires one tester. Items are taken from various sources, referenced in Appendix 2. For visual assessment, children who were short-sighted were assessed wearing glasses. Distance vision was not measured. Familiar pictures were used to test hearing. For expressive language, a meaningful sentence with at least seven words was considered to be age-appropriate. Items for cognition included culturally popular games (e.g., carom, ludo, soccer) as per ICF (WHO, 2001). Seizure was included as it is a functional co-morbidity. The entire test takes 20-45 minutes to complete, depending on the level of experience of the tester.

Responses are recorded dichotomously, i.e., whether the child is ‘able’ or ‘not able’ to complete the item for gross motor, fine motor, expressive language, cognition and self-care; ‘normal’ and ‘abnormal’ for vision and hearing; and ‘yes’ and ‘no’ for behavior problems and seizures. A Summary Sheet is filled in by domain at the end of the assessment, taking into consideration performance in the individual items. Preset criteria for severity ratings are provided. Categories of severity are: ‘mild’, ‘moderate’, and ‘severe’. An ‘uncertain’ category is provided when the respective activity (or lack thereof) may be questionable.

Additional information collected prior to administration of the RNDA includes: (a) chronological age; (b) a short history including socio-demographic information, birth history, nutritional history, and any health or developmental worries of care-providers; (c) anthropometry; and (d) a general physical examination.

Testers

Four child care professionals – one child health physician and three child developmental therapists – were the testers. All had a minimum of 5 years of experience in working with children with functional limitations. Developmental therapists are generic therapists with training in Early Child Development and clinical experience in a combination of physiotherapy, occupational therapy, and speech and language therapy, within a developmental framework.

Study Population and Place of Assessment

Young adolescents aged 10-16 completed years were recruited through convenience sampling from the Kalyani Inclusive School of Bangladesh Protibondhi Foundation (BPF) (<https://plus.google.com/106245999588508909915/about?gl=bd&hl=en>). In some cases their siblings, who were attending other schools, were also recruited. All were assessed within the Kalyani Inclusive School. There were no exclusion criteria.

Inter-rater Reliability

The RNDA was administered by one main tester at a time, while the others observed the procedure and recorded the responses on the Summary Sheet, without consultation with each other. Each tester administered the RNDA to at least 10 children.

Concurrent Validity

One of two trained psychologists, in the same testing session as the RNDA, administered an adapted version of the Weschler Intelligence Scale for Children, Revised (WISC,R) (Huq, 1994), considered the gold standard. Verbal intelligence quotient (IQ) (VIQ), Performance IQ (PIQ) and Full Scale IQ (FSIQ) were calculated.

Data Analysis

All data was recorded in a pre-coded form, and entered into a database. Analysis was done using SPSSpc software.

Inter-rater Reliability

Kappa coefficients of agreement (Fleiss, 1981) were calculated for each developmental domain by cross-tabulating the results of the main tester with each of the three other testers in the nine developmental domains recorded on the Summary Sheet. Mean kappa scores between all testers were then calculated.

Validity

Mean VIQ, PIQ, and FSIQ scores on the WISC,R were compared for RNDA outcomes, i.e., ‘any NDI’ (i.e., ≥ 1 NDI) versus no NDI, by ANOVA.

Ethical Considerations

For all children assessed on the RNDA, a written consent form was signed by literate mothers, while verbal consent was taken for those who were non-literate. Logistic support – travel cost and lunch – was provided to the families for attending the assessment session.

The research protocol was approved by the Ethical Review Committee of the Bangladesh Institute of Child Health, Dhaka Shishu Hospital (DSH).

RESULTS

Study Population

A total of 47 children (mean age 12.4 years) were recruited (Table 1) from the local urban population and almost three-fifths were from low income families. One-third of fathers and almost half the mothers could not read a newspaper. The majority of fathers were either skilled or unskilled laborers or in small businesses, and over half the mothers were housewives.

Neurodevelopmental Impairments on RNDA

Any (≥ 1) NDI was detected in 34 (72.3%) of the children (Table 1). The most common impairment ($n=33$, 70.2%) was cognitive. Impairments in vision ($n=2$, 4.3%), speech ($n=2$), self-care ($n=2$) and behavior ($n=1$, 2.1%) were less common. There were no impairments found in gross and fine motor, hearing and seizure domains.

Inter-rater Reliability

Kappa coefficients between the four testers showed complete agreement (1.00) in all domains (gross motor, fine motor, hearing, speech, cognitive impairments, behavior, self-care and seizures).

Comparison of 'Any (≥ 1) NDI' with WISC,R

Among the children with ($n=34$) and without ($n=13$) ≥ 1 NDI, there were 21-point, 20-point and 16-point differences in VIQ, FSIQ and PIQ (p -values=0.0001), respectively, with a mean difference of 19 points between the two groups (Table 2). Very poor scores were found in three

children in the group with NDIs, while the scores of some children with NDIs overlapped with those of children without NDI (Figure 1).

DISCUSSION

The study findings suggest that the RNDA can be applied by generic child health professionals to rapidly and validly ascertain neurodevelopmental status in young adolescents aged 10-16 years. As the mean IQ of those with NDIs was significantly lower than those without, the test may be utilized in lieu of psychometric tests in situations where technical expertise and resources are lacking, though determination of its accuracy would require a larger sample. In DSH, 16.3% of 300 children who presented to the Child and Adolescent Mental Health Clinic in a tertiary children's hospital in Dhaka city were >10 years of age (Islam et al, 2011), suggesting that there is a high level of need for assessment and provision of services. Formal psychometric tests generally are unavailable in Bangladesh for this age group of young adolescents; thus, problems may remain unrecognized, or diagnosis may become subjective and dependent on individual expertise and experiences of the health professionals. Identifying a range of problems, including cognitive deficits, therefore has positive implications for neurodevelopmental assessment of large populations of adolescent children for detection of impairments, so that appropriate interventions may be advised, including approaches to keeping young adolescents in school.

The high inter-rater reliability between child care professionals is consistent with that found previously for the RNDA in 0-9 year olds (Khan et al, 2010; Khan et al, 2013; Khan et al, 2014). This has important implications for human resource development in a country with sparse expertise in this field. It suggests that large numbers of generic child care professionals (e.g.,

school teachers) can be trained to apply the tool across the country, with a short period of training. It should be noted that the RNDA has been utilized in a country-wide survey in Bangladesh to estimate the prevalence of childhood autism and neurodevelopmental disorders (DGHS, 2013), and, after being used in a population-based study in Bhutan (Bhutan, 2010-2011) is being applied across most districts of Bhutan by school teachers to identify children with special needs (personal communication, Professor Tshering and Lasa Karma, May 2015).

The concurrent validity of the RNDA when compared with a standard psychometric test is demonstrated by the IQ differences seen in those with and without NDIs. Formal IQ testing is difficult to find in most LMICs, as each test needs to be adapted to the local culture and surroundings, which takes trained psychological expertise, resources and time. For the same to be achieved through a simple test such as the RNDA is a very positive indicator for its application within Bangladesh and in other LMICs.

There were several study limitations. Firstly, most children were enrolled from a low-income inclusive school where even those children considered to be developmentally age-appropriate by the school authorities might be in the border-line or mild categories of intellectual functioning due to poor nutrition, under-stimulation, etc. (Grantham-McGregor et al, 2007). Hence, a large majority of children were found to have cognitive impairments (i.e., 70.2%). On the other hand, only a small minority had other impairments, such as vision or speech deficits. Secondly, their adaptive functioning and resilience to difficult life circumstances could not be ascertained due to lack of a standardized tool for this age group. Both aspects – adaptive behavior and resilience – are being seen as more ordinary and embedded in normal development than thought previously

(Favey et al, 2007; Masten, 2001). Children living in challenging circumstances have been found to be advanced in adaptive behavior and many of the children with NDIs in this study might have scored age-appropriately (or perhaps even higher) had this been tested. In a study of malnourished children, all <10 years of age, we found that their adaptive behavior was by far better than their IQ scores (Khan et al, 1994). Thirdly, a larger sample size likely would have provided a better distribution of NDIs across all domains.

CONCLUSION

The RNDA shows promise as a reliable and valid tool for identifying NDIs when administered by a range of child care professionals to young adolescents aged 10-16 years. This builds on previous studies demonstrating the validity of the RNDA in under-10-year-old children, and thus extends the age-range for its use. Further refinement of the tool is needed for identification of specific impairments, such as motor impairments, hearing and seizures.

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Figure 1: Verbal (VIQ), Performance (PIQ) and Full Scale (FSIQ) IQ on WISC-R, by any (≥ 1) (n=34) or no (n=13) neurodevelopmental impairment (NDI).

Table 1: Demographic, household and neurodevelopmental characteristics of the assessed children.

Child and Household Variables	Total Number of Children=47 (100%)
<i>Mean age in years of assessed children</i> (SD; range)	12.4 (1.6; 10.0-16.0)
% female	47.9
<i>Household income in Taka</i> (Taka 76=1USD) <8000	34 (72.3%)
<i>Residence</i> Urban	46 (97.9%)
<i>Father's literacy (ability to read newspaper)</i> Cannot read	15 (31.9%)
<i>Mother's literacy (ability to read newspaper)</i> Cannot read	22 (46.8%)
<i>Father's occupation</i> Business Service Skilled worker Unskilled worker Professional Expired	16 (34.0%) 11 (23.4%) 12 (25.5%) 4 (8.5%) 2 (4.3%) 2 (4.3%)
<i>Mother's occupation</i> Housewife Skilled worker Domestic worker Professional Service	27 (57.4%) 8 (17.0%) 7 (14.9%) 3 (6.4%) 2 (4.3%)
<i>Children with neurodevelopmental impairments (NDIs) on the RND A Any</i> (=>1) NDI Any Cognition Vision Speech Self-care Behavior Gross motor	34 (72.3%) 33 (70.2%) 2 (4.3%) 2 (4.3%) 2 (4.3%) 1 (2.1%) 0 (0)

Fine motor	0 (0)
Hearing	0 (0)
Seizures	0 (0)

Table 2: IQ scores on the Wechsler Intelligence Scale for Children, Revised (WISC,R) by neurodevelopmental impairment status (N=47)

Specific IQ scores	Impairment Status (number of children)	Mean IQ	SD	P value
Verbal IQ (VIQ)	No impairment (13)	96.15	15.59	0.0001
	Any impairment (34)	74.91	15.41	
Performance IQ (PIQ)	No impairment (13)	86.00	11.31	0.0001
	Any impairment (34)	69.62	11.71	
Full Scale IQ (FSIQ)	No impairment (13)	90.46	14.03	0.0001
	Any impairment (34)	69.97	12.99	