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Validity of the 'Ten Questions' for Screening Serious Childhood Disability: Results from Urban Bangladesh

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Zaman S S (Department of Psychology, University of Dhaka, Bangladesh), Khan N Z, Islam S, Banu S, Dixit S, Shrout P and Durkin M. Validity of the 'Ten Questions' for screening serious childhood disability: results from urban Bangladesh. *International Journal of Epidemiology* 1990; 19: 613–620.

A survey of 2578 children aged two to nine years was carried out in Dhaka, Bangladesh, as part of a collaborative study to test the validity of a questionnaire (the Ten Questions) for screening severe childhood disabilities in community settings. Approximately 7% of the children were positive on the screen and this rate was slightly higher in boys than girls. The sensitivity, specificity and negative predictive value of the Ten Questions were perfect or nearly perfect for severe and moderate (serious) disabilities. The positive predictive value was only 22% for serious disabilities, but 70% of children classified as false positives were found to have mild disabilities or other conditions (such as ear infections) for which early detection and treatment could be beneficial. No major age or gender differences in the validity of the questionnaire were apparent, but this finding needs additional study and confirmation with studies based on larger samples. In general, the results indicate that the Ten Questions is a valid tool for screening serious disabilities in children and can potentially improve the efficiency of health services by reducing the number of children requiring attention from professionals. Future studies using the Ten Questions should foster greater attention to the dimensions of childhood disability as a public health problem in the less developed world.

The burden of childhood disability as a public health problem in developing countries remains relatively unrecognized. Basic data on frequencies and causes are necessary to bring more attention to this problem and to develop locally relevant programmes for primary and secondary prevention. The Ten Questions (see Appendix) was designed to provide a rapid and cross-culturally useful tool for detecting several types of disability in two to nine-year-old children in communities where resources are scarce and formal services for disabled children may be unavailable. Initial studies indicate that the Ten Questions are reliable when translated into a variety of dialects and administered by trained community workers. Once validated, the Ten Questions may serve as a case-finding tool for epidemiological studies, and as a basis for referring disabled children to services as appropriate services become increasingly available. The types of disability covered by the Ten Questions are blindness, deafness, mental retardation, speech problems, epilepsy and movement disorders. To be useful, the questionnaire should provide an effective screen for boys and girls alike within the target age range. A study was carried out in Dhaka, Bangladesh, to validate the Ten Questions as a tool for screening severe and moderate childhood disabilities. This paper examines the data from Dhaka to determine whether the Ten Questions does in fact appear valid for both genders as well as for older and younger children within the two to nine year age range.

We give special attention in this analysis to the variables gender and age of the child because, on the one hand, each variable is an important risk factor or potential risk factor for childhood disability, and, on the other hand, it is plausible that each variable could be associated with differential misclassification by the

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Ten Questions of non-disabled children as disabled (false positives) and disabled children as non-disabled (false negatives). For example, if the screen is found to be a more specific indicator of disability for older children than for younger children (within the two to nine year age range of the study), its use as a case-finding tool in epidemiological studies would result in bias due to over-identification of younger children as disabled. Similarly, bias would result if the Ten Questions differentially misclassifies boys and girls. The possible influence of gender on the validity of the Ten Questions is especially relevant in light of the cultural preference for sons in Bangladesh. It has been suggested that this preference is a causal factor in the excess of females in the infant and child mortality rates observed in Bangladesh,[1-3] and that a mechanism for this effect is a tendency of parents to expend greater health care resources on sons than on daughters.[4] In this context, because the screen relies on parents' reporting, it is important to show that it does not result in differential over-reporting of disabilities in boys (false positives) or under-reporting of disabilities in girls (false negatives).

With these considerations in mind, this paper examines the validity of the Ten Questions screen overall and stratified by the gender and age group of the child. Validity is evaluated in terms of sensitivity, specificity and positive and negative predictive value. In addition, prevalence estimates of disability (all types combined) and a summary of the types of disabilities identified during the course of the survey are given.

METHODS AND PROCEDURES

The Study Design and Sample

A two-stage design was followed to test the validity of the Ten Questions for screening disabilities. Stage I consisted of the household survey and screening of all children in the sample. Stage II consisted of comprehensive medical and psychological evaluations of all children with positive Ten Questions results plus a random sample of those with negative results. The medical assessment focused on diagnosing disorders of vision, hearing, speech and cognition as well as motor and seizure disorders. The purpose of the psychological evaluations was to assist in the diagnosis of mental retardation. The final diagnosis of mental retardation was made jointly by a paediatrician and psychologist after each had examined the child. The evaluations were done within two weeks of the screening and without knowledge of the child's screening result.

The design called for drawing a sample of about 2500 children between the ages of two and nine years from the Dhaka Municipal Area using a modified, multi-stage cluster sampling approach. First, 15 mahallahs (census enumeration areas) were selected randomly with probability proportionate to size[*] from among the 553 mahallahs that make up the Dhaka Municipal Area. The 15 selected mahallahs are distributed widely throughout Dhaka City. Five are characterized as urban slums, one is in a relatively affluent area, another is comprised of housing for government employees, and the remaining are in middle class residential and mixed residential and commercial areas. Next, a household was selected at random from within each of the 15 mahallahs and each successive household with at least one child in the target age range of two to nine years was selected for inclusion in the study until a total of about 170 children were included from each mahallah. The primary sampling unit is a mahallah, the secondary sampling unit is a household in which at least one two to nine-year-old child resides, and the ultimate sampling unit is a child within the target age range. The number of households selected from each mahallah ranged from 80 to 99. The final sample included a total of 1408 households and 2576 children. Only two households refused to participate in Stage I of the study. Because some households contributed more than one child, the observations are not strictly independent. Therefore, the confidence intervals for odds ratios (ORs) reported in this paper should be viewed as approximations.* Although households with two or more two to nine-year-old children are over-represented in this study, we feel this would not have seriously biased the point estimates of sensitivity, specificity or predictive value reported here.

The field staff for the study were all natives of Bangladesh and included: two college students who were responsible for identifying and numbering the households in the sample and for arranging for selected children to be brought to the clinic for evaluation; six community workers (all of whom had completed primary school) who were trained as interviewers to administer the survey forms and the Ten Questions; five psychologists (one of the psychologists, SZ, served as the principal investigator, one served as the field supervisor and also did clinical evaluations, and the remaining three did clinical evaluations); two paediatricians who performed the medical evaluations, two psychology graduate students who were responsible for data management and microcomputing, one data entry clerk and one driver.

[*] If the observations for children within the same households are associated, one would expect the direction of the association to be positive. In the case of positively associated observations, the confidence intervals estimated from the data should be too narrow rather than too wide. Therefore, the lack of strict independence of observations should not pose a threat to the main conclusion made from the data in Table 2, which is that there is little evidence for gender or age differences in responses to the Ten Questions.

The fieldwork began in July 1987 and was completed in October of the same year.

The Instruments

The screening instrument under consideration, the Ten Questions, consists of ten simple and direct questions concerning the child's development, abilities and general level of functioning.* The actual questions are given in an Appendix. A Ten Questions result is considered 'positive' if a problem is reported by the parent in response to any one or more of the Ten Questions.†

A Medical Assessment Form (developed by Leslie Davidson, Naila Khan, Marigold Thorburn *et al*) was used by the physicians for guiding and recording the results of the medical examination. The form includes sections on medical history, observation of function, physical examination, neurological examination, and testing of vision and hearing. On the last page of this form, diagnoses (including ICD-9 codes[6]) and disability ratings (none, mild, moderate and severe) are recorded for the following areas: gross motor, fine motor, vision, hearing, seizures, cognition, speech, nutritional status, psychiatric status, and other. Standard criteria were developed for making these ratings.‡ In the analyses reported here, moderate and severe disabilities were collapsed into a single category and labelled serious. The diagnosis of seizure disorders is made on the basis of medical history information only; it is regarded as more accurate than the screen because the physicians, unlike the community interviewers, were able to ask about seizure history in several ways and to probe for clarification. Under the category of cognition, the presence and severity of mental retardation is rated jointly by a physician and psychologist after the two professionals have evaluated the child independently, discussed their assessments and arrived at a consensual diagnosis.

The psychological evaluations incorporated standard psychological tests of cognitive abilities as well as adaptive behaviour. Each test was either developed or adapted for use in Bangladesh.

A Refusal Form was completed for all children who did not participate in the clinical evaluation even though they had been invited to participate. Additional forms were developed for and used in the study to collect background information about the children and communities as well as information about the treatment needs of children found to have disabilities. All forms administered as interviews were translated into Bangla (the national language of Bangladesh). All of the forms were pre-coded for computerized data entry.

Data Analysis

Typically, the values for sensitivity, specificity and positive and negative predictive value are obtained from a screening evaluation study by crosstabulating two dichotomous outcomes: the screening result (positive versus negative) by the diagnosis (e.g. disabled versus non-disabled). For the data from this study, however, because only a sample of children screened were clinically evaluated in Stage II, it is necessary to arrange the data in a 2 × 3 table, with the dichotomous screening outcome crosstabulated by the trichotomous outcome: disabled, non-disabled, not evaluated. The formulas for sensitivity, specificity, positive and negative predictive value, and prevalence that are appropriate for this study design are given in Shrout and Newman.[7] Note that these formulas assume that, within a given screening category (positive versus negative), the rates of disability in children who were not evaluated are the same as in the rates in those who were evaluated; the formulas then provide a weighted average of the results obtained for the subsample of children evaluated within each screening category (by multiplying the proportion disabled within each screening stratum by the proportion of all children screened who were in that respective stratum).

The sampling procedures used for this study were devised primarily for testing the instruments and for stimulating community-based rehabilitation programmes. Although the sample obtained is not a probability sample of all two to nine-year-old children in the city, it appears to be approximately representative of that population. Another limitation of the sample is that the number of children screened is too small to allow estimation of the prevalence of specific types of disability or of age-specific rates. Nonetheless, the crude prevalence estimates obtained from this study represent a significant contribution to our knowledge of childhood disability in the less developed world and, therefore, we include them in this report.

RESULTS

The age and gender distribution of the sample of children screened as well as the rate of positive responses on the Ten Questions screen are given in Table 1. This

* An earlier version of the Ten Questions was tested previously, see Belmont L. *The international pilot study of severe childhood disability: final report*. Utrecht, Netherlands: Bishop Bekkers Institute, 1984.

† Probe questions have been added to the Ten Questions to control the occurrence of false positive results; these will be analysed in a later report.

‡ An unpublished Medical Assessment Form Manual describing the criteria used in the study for disability diagnoses and severity ratings is available upon request from the last author.

table shows that in both boys and girls the age distribution is relatively even, and that there are slightly more boys than girls, with boys comprising 52% of the sample. The per cent positive on the Ten Questions is lower for four and five-year-olds than for other ages, and this difference is most marked for four-year-old girls. When all ages are combined, the probability of screening positive is higher for boys than girls (7.7% versus 5.8%), but this difference is not statistically significant.

Table 2, column 1 shows the number and per cent of children with positive responses to each of the individual Ten Questions, and to any one or more of the questions. Hearing problems and unclear speech were the most common types of problems reported, while comprehension and learning problems were the least common. Column 2 shows the odds ratios (ORs) indicating for each question and for the Ten Questions as a whole (bottom row) whether boys were more likely than girls to have a positive response. For one type of problem, unclear speech, the OR was significantly different from one; in this case the point estimate of the OR is 2.1, indicating that parents were about twice as likely to report unclear speech for sons than for daughters. There were no significant gender differences for any other type of problem, or for a positive Ten Questions result (ie, any one or more problems reported, bottom row).

In column 3 of Table 2, the ORs indicate whether older (five to nine-year-old) children were more or less likely to have problems reported than younger (two to four-year-old) children. For two types of problems, hearing and slowness (ie, whether the child appears generally slow and backwards in comparison to other children the same age), older children were significantly more likely than younger children to be positive. For one problem, no speech, there is a significant difference in the opposite direction; younger children are more than twice as likely to have this problem than older children. For the remaining seven types of problems and overall for a positive screening result (bottom row) there were no significant differences between children in the two age groups.

As mentioned, the design called for all children with positive screening results plus a random sample of those with negative results to be clinically evaluated. Table 3 gives for each age group the number of children actually evaluated and the proportions of these who were boys and who were screened positive. It also gives the number and proportion of those seen who were found to have a serious disability. Note that prevalence estimates cannot be made directly from the information in this table because disabled children were over-represented in the sample evaluated (approximately half of the children in the sample evaluated were screened positive, while the remaining comprised the random sample of screened negative children selected for evaluation). The appropriate formula for estimating prevalence from these data is a weighted average of the prevalence estimated in those screened positive and those screened negative, and is described by Shrout and Newman[7] among others.

There were 35 children among the 359 evaluated who were found to have severe or moderate (serious) disabilities. A total of 55 serious disabilities were diagnosed, with some of the children having multiple disabilities. The kinds of serious disabilities identified and their distribution are given in Table 4.

Table 5 gives the screening evaluation results and prevalence estimates for all children combined, for boys and girls, and for older and younger children. As mentioned, these estimates are based on the subsample of 359 children referred for clinical evaluation and are adjusted for the fact that children with positive screening results are over-represented within this subsample. The values used to estimate the statistics presented in Table 5 are given in Table 6. Both sensitivity and negative predictive value are 100%, indicating that all 35 children found to have serious disabilities were positive on the Ten Questions. At the same time, these

TABLE 1 *Age and gender distribution of the sample, and the per cent positive on the Ten Questions (Q)*

Age	Total		Boys		Girls	
	No.	%TQ+ive	No.	%TQ+ive	No.	%TQ+ive
2	318	7.2	176	6.8	142	7.8
3	299	6.7	161	6.8	138	6.5
4	363	4.4	180	6.1	183	2.7
5	351	4.3	183	4.4	168	4.2
6	290	9.0	154	10.4	136	7.4
7	373	7.5	186	9.1	187	5.9
8	269	8.6	145	11.0	124	5.7
9	313	8.3	161	8.1	152	8.6
Total	2576	6.9	1346	7.7	1230	5.9
	(100%)		(52%)		(48%)	

TABLE 2 *Frequencies and Odds Ratios (OR) of Individual Questions (Rows 1–10) and the Ten Questions (TQ) as a Whole (Row 11)*

Question		No. positive	(%)	Boys versus girls OR	(95% CI)	Older versus younger OR	(95% CI)
1.	**Milestones**	27	(1.1)	1.5	(0.7, 3.3)	0.6	(0.3, 1.2)
2.	**Vision**	24	(0.9)	0.8	(0.4, 1.7)	1.4	(0.6, 3.4)
3.	**Hearing**	50	(1.9)	1.4	(0.8, 2.4)	*2.7	(1.3, 5.6)
4.	**Comprehension**	19	(0.7)	0.8	(0.3, 2.0)	1.6	(0.6, 4.4)
5.	**Movement**	25	(1.0)	1.2	(0.5, 2.5)	1.1	(0.5, 2.4)
6.	**Seizures**	38	(1.5)	1.7	(0.9, 3.4)	1.3	(0.7, 2.6)
7.	Learning	19	(0.7)	0.7	(0.3, 1.6)	0.8	(0.3, 2.0)
8.	No speech	23	(0.9)	1.7	(0.7, 3.9)	*0.4	(0.2, 0.9)
9.	Unclear speech	52	(2.0)	*2.3	(1.2, 3.8)	0.9	(0.5, 1.6)
10.	Slowness	28	(1.1)	1.9	(0.9, 4.1)	*4.5	(1.5, 13.9)
11.	Positive on any 1 or more questions (TQ+ive)	177	(6.9)	1.3	(1.0, 1.8)	1.2	(0.9, 1.7)

Notes:
1. Column 1 gives the frequencies and per cent positive responses among the 2576 children surveyed.
2. Column 2 gives the ratio of the odds of a positive response to the questions among boys to the same odds among girls.
3. Column 3 gives the ratio of the odds of a positive response among older (ages 5–9) children to the same odds among younger (ages 2–4) children.
4. *indicates that the 95% confidence interval does not include unity.

35 children are only about 22% of all children who were positive on the Ten Questions and evaluated, and thus the estimated positive predictive value of the screen for serious disabilities is only 22%. The overall prevalence estimate is about 16 per 1000, and the prevalence appears to be slightly higher for boys than girls, and higher for older children than younger children.

There were a total of 123 children classified as false positives on the Ten Questions when the criterion of serious disability is used. However, 86 (70%) of these children were found on clinical evaluation to have conditions rated as mild disabilities (such as mild mental retardation, speech problems, night blindness, hearing loss, motor weakness, epilepsy) or as other health problems that could potentially lead to disability (such as malnutrition, ear infections). When these milder conditions are included within the definition of a case, the positive predictive value nearly doubles, increasing to 41%. However, expanding the case definition to include milder conditions costs in terms of sensitivity, which drops from 100% to only 31%.

DISCUSSION

These results show that the Ten Questions is a sensitive screen for serious disabilities in two to nine-year-old children, but that most of the children who screen positive are not seriously disabled. With a positive predictive value of only 22%, the Ten Questions cannot function well on its own as a case-finding tool for epidemiological studies of serious disability or as a basis for referring seriously disabled children to rehabilitation services. The fact that no cases of moderate or severe disability were missed, however, supports the conclusion that the Ten Questions does function well

TABLE 3 *Age and gender distribution of the 359 children clinically evaluated in Stage II of the survey, proportion of the same children who were positive on the Ten Questions (TQ), and number and proportion found to be seriously disabled*

Age	Number evaluated	% Boys among all evaluated	% TQ+ive Among all evaluated	Number (and %) with serious disabilities
2	36	58	50	5 (14)
3	39	44	49	5 (13)
4	47	60	34	1 (2)
5	45	51	33	4 (9)
6	48	56	48	2 (4)
7	61	56	43	5 (8)
8	39	56	49	7 (18)
9	44	45	52	6 (14)
Total	359	53	49	35 (10)

TABLE 4 *Number of each type of disability among the 55 serious disabilities identified**

Type of disability	No.	Proportion of total
Cognitive	20	0.36
Speech	15	0.27
Hearing	10	0.18
Movement	5	0.09
Vision	4	0.07
Epilepsy	1	0.02
All types	55	1.00

*There were a total of 35 children with serious disabilities, some of whom had multiple disabilities.

as a screening tool when, as in this study, all children screened positive are referred for more definitive evaluations. Although the screen produces many false positives, it still reduces the number of children to be evaluated by professionals from 100% to only about 7% (ie, the per cent with one or more problems reported on the Ten Questions).

The observation that 70% of the children classified as false positives (using severe or moderate disability as the criterion) had either mild disabilities or other health problems strengthens the evidence for the validity of the Ten Questions. It suggests that referring all children with positive results will not necessarily result in inefficient use of professional resources, since it is likely that early identification and treatment of less severe conditions could serve to prevent future cases of more severe disability. Before the Ten Questions can be recommended as a screen for less severe conditions, however, further studies are needed of its sensitivity for these conditions.

Few differences were observed in the results for boys and girls, and for older and younger children within the two to nine year age range. The only significant difference between boys and girls in the frequency of a positive response to one of the Ten Questions was for speech problems (OR = 2.1, Table 2). This difference is not inconsistent with what child development specialists observe in developed countries, and, therefore, does not detract from the validity of the screen. Comparing older and younger children, the only significant differences observed were that for older children hearing problems (Question 3) and general slowness (Question 10) were reported more frequently than they were for younger children (ORs 2.7 and 4.5, respectively, Table 2); and that younger children were more than twice as likely as older children to have no speech. Despite these differences, there were no significant age or gender differences in the probability of being positive on the Ten Questions (any one or more question, Table 2). Thus, the screen does not appear to grossly over-identify or under-identify one or another of these groups. The best evidence of whether the Ten Questions over- or under-identifies boys or girls, or older or younger children is to be found in the validity results. The parameters sensitivity, specificity and negative predictive value (Table 5) are all either perfect or nearly perfect for all groups and thus provide no evidence for differential misclassification. The positive predictive values in Table 5 are considerably less than unity; they show no apparent age difference but they do show a gender difference: the positive predictive value for boys is only 20% while that for girls is 26%. This difference is consistent with the observed tendency for parents in Bangladesh to display more concern for the health of sons than daughters.[3-5] This difference and its significance will be explored in future work.

For the moment, the magnitude of this gender difference in positive predictive value does not appear to be great enough to pose a serious threat to the validity of the Ten Questions.

Future analyses of the data from Dhaka (as well as from related surveys carried out elsewhere in Bangladesh and in Jamaica and Pakistan) will aim to determine whether, by using probe questions (asked whenever a problem is reported by a parent in response to one of the Ten Questions), the number of false positives can be reduced without causing a great loss in sensitivity. If the probe questions are effective in this regard, it may be possible for the Ten Questions with probes alone to serve as a valid case-finding tool. This would be extremely cost-effective since the screen

TABLE 5 *Estimates of the validity of the Ten Questions for screening serious disabilities, and estimates of prevalence of serious disability in Dhaka (based on the subsample of 359 children referred for clinical evaluation; see text for explanation)*

	All children	Boys	Girls	Older children (5–9 years)	Younger children (2–4 years)
Sensitivity:	1.00	1.00	1.00	1.00	1.00
Specificity:	0.95	0.94	0.96	0.94	0.95
Positive predictive value:	0.22	0.20	0.26	0.23	0.21
Negative predictive value:	1.00	1.00	1.00	1.00	1.00
Prevalence (per 1000):	16	17	15	17	12

TABLE 6 *Values used to obtain the results in Table 5*

	All children	Boys	Girls	Older children (5–9 years)	Younger children (2–4 years)
Proportion positive among all screened:	0.069	0.077	0.059	0.074	0.061
Proportion with serious disabilities among all who screened positive:	0.222	0.196	0.258	0.226	0.211
Proportion with serious disabilities among all who screened negative:	0	0	0	0	0

is administered by non-professionals. Professional services could then be devoted more exclusively to evaluation and treatment of children with disabilities.

CONCLUSION

These initial results concerning the validity of the Ten Questions in Dhaka are encouraging for at least three reasons. First, they show no evidence of serious age or gender bias. Second, they suggest that the questionnaire not only provides a sensitive screen for severe and moderate disabilities in two to nine-year-old children, but that thirdly it also effectively reduces the proportion of children in a community that would need professional evaluations (if the aim was to identify all severely and moderately disabled children in a community) from 100% to only about 7%. At the same time, the moderately low positive predictive value of 22% reinforces the conclusion that the questionnaire cannot function alone as a method of case identification or as a basis for referring children to treatment. In general, these results support the conclusion that the Ten Questions is best used as a screening tool, whereby children with positive results are referred for more definitive evaluations.

Future analyses will attempt to replicate these findings with data from other areas of Bangladesh and from other countries. They will also attempt to determine whether probe questions added to the Ten Questions and administered by community workers can effectively reduce the occurrence of false positive responses and provide valid information about the nature of disabilities reported without at the same time contributing excess false negatives. Finally, future analyses will explore the utility of the Ten Questions as a screen for less severe disabilities and other types of health problems among young children in community settings. It is hoped that this work will result in greater attention to childhood disability as a public health problem in the less developed world.

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APPENDIX B

Ten Questions

1. Compared with other children, did the child have any serious delay in sitting, standing or walking?
2. Compared with other children does the child have difficulty seeing, either in the daytime or at night?
3. Does the child appear to have difficulty hearing?
4. When you tell the child to do something, does he/she seem to understand what you are saying?
5. Does the child have difficulty in walking or moving his/her arms or does he/she have weakness and/or stiffness in the arms or legs?
6. Does the child sometimes have fits, become rigid, or lose consciousness?
7. Does the child learn to do things like other children his/her age?
8. Does the child speak at all (can he/she make himself/herself understood in words; can he/she say any recognizable words)?
9. For three to nine-year-old children ask: Is the child's speech in any way different from normal (not clear enough to be understood by people other than his/her immediate family)?
9. For two-year-old children ask: Can he/she name at least one object (for example, an animal, a toy, a cup, a spoon)?
10. Compared with other children of his/her age, does the child appear in any way mentally backward, dull or slow?

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