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Usefulness of child development assessments for low-resource settings in francophone Africa

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Abstract

Objective—Few tools are available to screen or assess infant's cognitive development, especially in French-speaking Africa. This study evaluated the use of the French translation of the Mullen Scales of Early Learning (MSEL), and the 'Ten Questions' questionnaire (TQ) in 1-year-old children in Benin, a francophone country.

Methods—A cross-sectional study was conducted in three health centers serving a semi-rural area in Benin. Three hundred fifty-seven children aged 12 months and their mothers were enrolled in 2011. Infant development was assessed at local health centers followed by a home visit to collect information on socioeconomic status, maternal Raven score, maternal depressive symptoms, and mother-child interactions (HOME Inventory) and to administer the TQ.

Results—The infant's gender (female), the HOME and maternal education were associated with a higher Early Learning Composite score in multivariate analyses ($P=.02$, $P=.004$, $P=.007$, respectively). The HOME and family wealth were also associated with the gross motor scale ($P=$

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03 and $P=.03$, respectively). Mothers were more likely to report difficulties on the TQ when the child presented lower score on the MSEL. When considering the gross motor scale as the gold standard to define moderate delays, the two combined motor-related questions on the TQ showed good sensitivity and specificity (76.5 and 75.7).

Conclusion—In a low-resource rural setting in Africa, the TQ effectively identified three-quarters of 1-year-old infants with delayed development. After this screening, the MSEL may be useful for further assessment as it showed good feasibility and sensitivity to known risk factors for poor child development.

Keywords

Child development; Mullen Scales of Early Learning; Ten Questions Questionnaire; HOME scale; Africa

INTRODUCTION

The early years of childhood, from birth to 5 years of age, are the most important period of growth and development. Gradually, over these 5 years children develop the ability to walk, talk, write, express themselves and communicate. Children's development is complex and includes multiple and interdependent domains.¹ In addition, children's development is strongly influenced by social and biological risk factors including maternal responsiveness, family support, psychosocial risk factors, poverty as well as premature birth, infection, nutrition, and genetics.

In high-income countries, many tools have been developed over the last 40 years to assess children's development. However, there are fewer appropriate tools available in low-income countries, and to our knowledge no standardized and comprehensive tool has been used so far in Benin, a francophone country in sub-Saharan Africa.²

On the occasion of a prospective birth cohort study studying the impact of maternal anemia on infant cognitive development in Benin, the Mullen Scales of Early Learning (MSEL) and the 'Ten Questions' Questionnaire (TQ) were used to assess infants' cognitive development and to screen for disabilities in 1-year-old children, respectively. The MSEL is a well-validated (in English), individually administered, comprehensive measure of cognitive functioning for infants and preschool children, from birth through 68 months.³ It has good correspondence validity to the Bayley Scales of infant development, and has been widely used in high-income anglophone countries.⁴⁻⁷ The TQ has been designed to screen for disabilities in children from 2 to 9 years of age. It is a rapid and low-cost screening tool to identify children's disabilities in low-income countries and has never been used in 1-year-old children.

Our goal was to provide tools to assess infant motor and cognitive development and to screen for poor infant development in a semi-rural setting in a French-speaking, low-income African country. Specifically, we first studied predictors for poor child development, using scores derived from MSEL and socioeconomic and maternal risk factors at 1 year of age, and second we studied the validity of a subset of the TQ in 1-year-old Beninese children, using the MSEL as the gold standard.

METHODS

Study Design

The study population for these analyses included the first 357 of 700 children born of mothers enrolled in 2011 in a trial comparing two Intermittent Preventive Treatments for malaria, the MiPPAD (Malaria in Pregnancy Preventive Alternative Drugs) study in Benin, West Africa. All singleton births were included. Pregnant women were followed from the second trimester of pregnancy through delivery, and offspring from birth to 12 months of life.

Study Site and Population

The study was conducted in the district of Allada, a semi-rural area located 50 km north of Cotonou, the capital of Benin. The study participants were recruited in three health centers: Allada, Attogon, and Sékou. The study population was composed of children aged 12 months and their mothers.

Data Collection Procedure

At local health centers, infant development was assessed by research nurses trained specifically in the use of the Mullen Scales of Early Learning. Three days later, a home visit was made by a different nurse or a psychologist. During this visit, a questionnaire on socioeconomic status, the Raven matrices,⁸ the Edinburgh Postnatal Depression Scale (EPDS),⁹ and the Home Observation for the Measurement of the Environment (HOME) Inventory¹⁰ were used. The TQ was also administered during the home visit.

Measures

Mullen Scales of Early Learning (MSEL)—The MSEL covers various domains to assess childhood development.³ The five Mullen Scales are Gross Motor, Fine Motor, Visual Reception, Receptive Language, and Expressive Language. After scoring all items and computing raw scores, these raw scores are converted into a normative score called the *T* score for each of the five Mullen Scales. *T* scores from the Fine Motor, Visual Reception, Receptive Language, and Expressive Language scales are converted into the Early Learning Composite score, which provides the general cognitive factor underlying all cognitive performance.³

Translation and adaptation of the MSEL—The MSEL was translated and adapted in four steps: linguistic translation, review, training, and pilot testing.

Linguistic translation: Following the World Bank Human Development Group recommendations,¹¹ the measures were first translated from English into French by a psychologist and then the measures were independently back-translated from French to English by another psychologist. Both English versions were compared for accuracy by the principal investigator (FBL) and a pediatric epidemiologist (LLD) and the translation modified accordingly. The back-translation was reviewed and approved by Pearson's assessment, the company holding the MSEL copyright. The MSEL instructions for parents were translated into Fon, the local language.

Training: Study nurses and the coordinator psychologist were specifically trained by a psychologist (MB) and the principal investigator (FBL) to administer the MSEL, the HOME, the EPDS, the Raven matrices, the questionnaire and the TQ during a two-week training.

Pilot study: A pilot study was conducted for the MSEL as well as for the TQ, HOME, EPDS, Raven matrices and questionnaire. Fifteen children have been assessed during the two-week training. Further thirty-two children have been assessed the following month before the beginning of the study.

Review: The review process took place during and after the two week training and the pilot study. MJB (psychologist), FBL (PI), GKK (Beninese doctoral student and physician), MJA (Beninese pediatrician) and RZ (Beninese psychologist field coordinator) were present during this session in addition to five nurses. Only three items have been modified. First, a small potato chip has been used instead of a cheerios to use of locally available materials. Second, children are used to refer to their mother. Also, one point was scored if the child gave the ball to his/her mother instead of throwing the ball underhand. Third, the question ‘Why do we have refrigerators’ has been replaced by ‘why do we have lanterns’ because many families do not have refrigerators. During and at the end of the pilot study, nurses’ administration and scoring were audited and reviewed before children were enrolled.

Quality control: Two months after the beginning of the study, a review with the PI took place in the field with assessors and retraining. At the end of each week, the field coordinator (RZ) and assessors met to review difficulties that occurred during examinations. Difficulties were discussed and clarifications were asked to MJB and FBL if needed.

Inter-rater Reliability: Three nurses administered the MSEL. They assessed 179, 95 and 83 children, respectively. The assessor having administered most of the tests had been defined as the ‘gold standard’ interviewer.¹¹ Means and SD were close among assessors for the composite score: 98.1 (13.5), 97.2 (13.7), and 100.1 (13.6), respectively. The correlation score for inter-rater reliability between the gold standard interviewer and other assessors ranged from 94 to 100% with a mean correlation score of 98%.

Ten Questions Questionnaire (TQ)—This short questionnaire (10 questions) asks a caregiver to consider the child in comparison to others in his or her age group and includes simple questions addressing the child’s vision, hearing, seizures, cognitive development, and motor development.^{12,13} The TQ can be understood across low-resource settings without relying on specific questions that may be culturally inappropriate.¹⁴ The TQ screen is considered as positive if any one of the questions is positive. Although it has been validated for children from 2 to 9 years of age, we used it in 1-year-old children, excluding Question 9, related to speech, which is not age-appropriate for 1-year-old infants.

Socioeconomic status—We used two variables to assess family socioeconomic status:¹⁵ family wealth and maternal education. The family wealth scale was assessed using a scoring instrument incorporating a checklist of material possessions (radio, television, bike, motorbike, and car), possession of cows and access to electricity. Maternal education included schooled and unschooled.

Home environment—The quality of the home environment was measured by the Home Observation for the Measurement of the Environment (HOME).¹⁰ The HOME is used to assess the stimulation and learning opportunities offered by the child’s home environment. The HOME adaptation followed the following steps: formal training of the team in classrooms, pilot study in the field, adaptation of items according to the pilot study, and final review with the whole team. After the pilot study including about ten home visits, six items were modified to be relevant to the African context. Because during the pilot study only one family owned a toy, the ‘Learning Materials’ section was reduced to four questions. The questions related to books were changed into: ‘At least two books are present or can be

seen'; 'the child owns one or more books'. One item related to the child being outside of the house was removed as children spend most of the day outside.

Raven's Progressive matrices (RPM)—Raven's Progressive Matrices (RPM), a nonverbal test, was used to assess the mother's intellectual quotient.⁸ The matrices are made up of a series of diagrams or designs with one part missing. The mother is expected to select the correct part to complete the designs from a number of options printed beneath.

Edinburgh Postnatal Depression Scale (EPDS)—We used the EPDS to assess maternal depressive symptoms.^{9,16-18} Scores derived from the EPDS were analyzed as a continuous variable. The EPDS, already available in French, was translated into Fon.

Statistical analysis—Our statistical analysis was performed in three steps. In the first step, we described the different scales of the MSEL, overall and by gender, and socioeconomic and maternal characteristics. Then Pearson's correlation was used to assess associations between the following variables: Home environment, family wealth, and maternal intellectual quotient. Second, we performed univariate analyses to study the associations between the scores derived from the Mullen Scales and the covariates (infant's sex, home environment, family asset, marital status, maternal depression symptoms, Raven score, and maternal education). Finally, a multiple linear regression was performed to study associations between socioeconomic and maternal factors and the early composite and gross motor scales. Covariates included in the multivariate analysis were selected based on our results and according to the literature. In the third step, associations between scores derived from MSEL and nine items of the TQ were examined. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of a subset of the TQ were computed using the MSEL as the gold standard where no other cognitive tool was available. The analysis was based on the US normative cutoffs: mean minus one standard deviation (SD) for mild delays (39.7 for the Gross Motor Score and 83.9 for the Composite Score), and then the mean minus two standard deviations for moderate delays (29.3 for the Gross Motor Score and 68.5 for the Composite Score).

Double data entry was performed using Epidata®. Pearson's correlation was used to assess associations between quantitative variables. Chi-square tests (or Fischer's exact test as appropriate) and *t*-tests were used to compare percentages and means, respectively. A *P*-value < 0.05 was considered significant. All the analyses were performed with Stata software, version 11.0.

Ethics—The study's protocol was approved by the University of Abomey-Calavi's institutional review board, New York University, Michigan State University institutional review boards, and the French Institut de Recherche pour le Développement's (IRD) Consultative Ethics Committee. All women who participated in this study signed informed consent before enrollment.

RESULTS

Three hundred fifty-seven subjects were assessed between April and December 2011 and included in our analyses. The Mullen composite score was lower in boys [96.9 (SD 13.2)] compared to girls [99.7 (SD 13.8)] (borderline significance, *P* = .05; Table 1). Similarly, Receptive Language was lower in boys [45.0 (SD 6.7)] than in girls [46.5 (SD 6.2)] (*P* = .02). Ninety-three children (26.1%) were classified as having mild motor delays, 17 (4.8%) moderate motor delays, 54 (15.1%) mild cognitive impairment, and nine (2.5%) moderate cognitive delays. The mean scores and SD for the index of family wealth, the HOME, the Raven, and the EPDS were 5.6 (2.9), 26.6 (2.5), 15.6 (5.1), and 8.3 (3.8), respectively. Most

families were monogamous (60% versus 40% polygamous). Only 40% of mothers had attended school.

The HOME score was correlated with both the family wealth and maternal Raven score ($P < .001$). Family wealth and maternal Raven score were also correlated ($P < .001$). Mothers with some education showed higher Raven scores compared with mothers without education (16.45 versus 14.5; $P < .001$). The HOME score was higher in mothers with education compared with mothers without education (27.4 vs 26.1; $P < .001$). Maternal education was also associated with family wealth (6.6 vs 4.9; $P < .001$).

Association between scores derived from the MSEL and known risk factors for poor child development (Table 2)

The Early Learning Composite Score of the MSEL was significantly associated with the home environment ($P < .001$), family wealth ($P = .028$), and the Raven score ($P = .003$). More advanced gross motor development was significantly associated with the home environment ($P < .001$) and family wealth ($P < .001$). Multivariate analysis showed that the infant's gender (female), home environment, and maternal education were significantly associated with a higher Early Learning Composite Score ($P = .02$, $P = .004$, $P = .007$, respectively). Home environment and family wealth remained significantly associated with the gross motor scale in the multivariate model ($P = .03$ and $P = .03$, respectively), but not the infant's gender.

Association between scores derived from the MSEL and a subset of the TQ in 1-year-old Beninese children (Table 3)

The percentages of positive screening results for each question are presented in Table 3. Using the nine questions, TQ was considered positive for 71% of children. The Gross Motor scale from the MSEL was significantly related to the two motor TQ questions: developmental milestones (mean score 40 when the question was positive versus 55 when the question was negative, $P < .001$) and movement (40 versus 52, respectively, $P < .001$). The Gross Motor scale was also associated with non-motor questions: comprehension ($P < .001$), seizure ($P < .05$), and intellectual impairment ($P < .001$). Positive screening results for developmental milestones and movement were significantly related to lower scores derived from the Mullen composite, Visual Reception, Fine Motor, Expressive Language, and Receptive Language scales.

Validity of a subset of the TQ: Sensitivity, specificity, PPV, and NPV (Table 4)

Using the Gross Motor Score to define moderate delays (mean minus 2 SD) we found that the sensitivity and the specificity for question 1 (developmental milestones) were 76.5% and 78%, respectively. Regarding question 5 (movement), sensitivity and specificity were respectively 47.1% and 92.9%. When we used these two questions simultaneously and for the same cutoff, the sensitivity and specificity were 76.5% and 75.7%. Using all nine questions of the TQ, sensitivity and specificity were 81% and 31%, respectively. Using the composite score as the gold standard to define moderate delays, sensitivity and specificity were respectively 77.8% and 74.6% when we used questions 1 and 5 simultaneously.

DISCUSSION

This is the first study using the French version of the MSEL and the first study using comprehensive child development assessments in Benin. We observed that these developmental assessments provided useful tools that could be easily used by nurses in a semi-rural area in sub-Saharan Africa in 1-year-old children where access to specialized care is limited. The multivariate analysis showed that the infant's gender, home environment, and maternal education were the most important predictors of poor cognitive development.

Home environment and family wealth were also significantly associated with motor development. No association was found between maternal depression and children's cognitive development at 1 year of age. The two motor-related questions on the TQ used together showed adequate sensitivity and specificity to screen moderate delays in both the Gross Motor and the Composite Scales of the MSEL where resources to evaluate development are limited.

We translated and back-translated the MSEL into French and it is therefore the first study to use the French version of the MSEL. This translation of the MSEL was strongly associated with known risk factors for poor child development. This variation of the mean scores varying according to socioeconomic and maternal variables suggests that the MSEL is sensitive to risk factors for poor child development. In older Anglophone children (2 to 4 years old), the MSEL has also proven sensitive to developmental outcomes for early intervention studies with participants affected by HIV in rural low-resource settings.¹⁹ Our results suggest that the MSEL is feasible for use by nurses trained in the instrument in a clinical setting. This is an important finding as few tools assessing infant development and disability have been used and studied in low-resource settings in French-speaking Africa. Another strength of the study is that we used multiple indicators to assess socioeconomic status and maternal characteristics with standardized tools (Home, Raven, EPDS).

The most widely studied construct variable in the social sciences is socioeconomic status. Several ways have been proposed but most include some quantification of family wealth, parental education, and occupational status.¹⁵ Indeed, both maternal education and family wealth were associated with infant cognitive development. Other studies have also reported associations between family socioeconomic status and infant cognitive development.²⁰⁻²² The present results showing an association between the HOME and child development are consistent with other studies.²³

As presented by Walker et al.,¹ a theoretical framework may hold relationships between distal (poverty, socio-cultural factors), proximal factors (psychosocial, including parenting factors, and biological factors) and child development. Accordingly, in our study, both distal (maternal education, family wealth) and proximal factors (HOME) were associated with child development. Proximal factors may have a stronger impact than distal factors on child development.^{23,24} Some authors showed no direct effect of socioeconomic status on child cognitive development in Kenya and Uganda.^{23,24} These studies took into account the child's nutritional status that may explain discrepancies with our results.

No association was found between MSEL and maternal depression. In 1999, Cooper et al. determined an association between postpartum depression and disturbances in the mother–infant relationship in Khayelitsha, a South African peri-urban settlement. They showed that maternal depression was associated with insensitive engagement with infants.²⁵ However, interestingly, our results are consistent with a study conducted in North Carolina using the same tools as in our study: in 2011, Keim et al. observed no significant negative association between cognitive development at 1 year of age measured by the MSEL and postpartum depressive symptoms measured by the EPDS.⁷

Although there is a need for additional psychometrics in future studies, providing reliability and validation psychometrics for all of the assessments adapted to this context in rural Benin was far beyond the scope of our study. This is primarily because there are no developmental gold standard assessments (e.g., the Bayley Scales of Infant Development) available in this setting, nor are there gold standard or clinical diagnostic tests available for our maternal measures (maternal depression or nonverbal intelligence) and for evaluating the quality of caregiving in the home environment. However, the measures we selected have been

reasonably adapted for such use in low-resource African settings, and were among the best candidate measures available for assessing those domains in a rural healthcare setting in Benin. This study is also rich in construct validity in that the TQ, socioeconomic status, HOME, and Raven were predictive of MSEL developmental outcomes in a manner consistent with what has been documented in English speaking areas.²⁶ It does provide strong inter-rater reliability, and shows evidence of the successful adaptation and implementation of important assessments with very young children and their mothers in a low-resource setting.

The validity of TQ has been widely investigated. One study was conducted in three countries (Bangladesh, Jamaica, and Pakistan) involving over 22,000 2- to 9-year-old children. The authors found that the specificity of the TQ as a screen for serious disability was 0.92 in Bangladesh, 0.85 in Jamaica, and 0.86 in Pakistan. Sensitivity for cognitive disability was 0.82 in Bangladesh, 0.84 in Pakistan, and 0.53 in Jamaica.¹² The TQ has also been validated in India and Kenya.^{27,28} All three studies were conducted in children from 2 to 9 years of age. To our knowledge, the present study is the first to investigate the validity of the TQ in 1-year-old infants. The results show that the TQ as a whole is not useful in screening for neurological disability in 1-year-old infants given the high number of false-positive results. However, we found that Questions 1 and 5, the two questions related to motor function, may be useful to screen for moderate to severe delays.

In our 1-year old population, the two motor-related questions on the TQ were highly associated with the MSEL, especially the Early Learning Composite Score and the Gross Motor Score. This was also the case in Anglophone Africa with older children with HIV (2 to 5 years of age). In these rural Ugandan children, the TQ showed good correspondence validity to the MSEL.¹⁴ Speech, hearing, and learning difficulties reported on the TQ were significantly related to Mullen Expressive and Receptive Language delays, as well as overall MSEL cognitive ability.

This study was conducted in the context of a clinical trial providing free treatment for diseases. This may have resulted in an overestimation of the MSEL scores in our study compared with the general population. On the other hand, the maternity wards included in the study were all public. This may have led to an underestimation given the probable relatively lower socioeconomic status of this population compared with private maternity wards. Overall, our estimates may be close to estimates found in the general population in a semi-rural area in Benin. These are the first estimates available in Benin and may be useful for comparison in the clinical setting or in research. For this analysis, we could not take into account other risk factors for poor child development such as medical risk factors (low birth weight, prematurity, and children's nutritional status). This will be examined in the future when all data are available.

We used the MSEL to assess cognitive and motor development in a Beninese population because there was no existing tool that had been developed nor validated in this population as it has been done for example elsewhere.²⁹ We used American norms to define cutoffs for delays as there were no Beninese norms at the time of the study. Scores were standardized with American norms. However, the mean scores observed in our 1-year-old population were close to those observed in the US population. Therefore, using standardized scores should not have changed significantly our results compared with raw scores. Discrepancies may be more pronounced at a later age where using raw scores may be more accurate in school age children.

In this setting, pediatricians and neurologists are not available. Our study suggests that a simple screening involving the two motor questions of the TQ may be administered by

nurses in health centers on the occasion of a systematic health visit and will identify almost three-quarters of the children with delayed development or disability. This would enable those screening positive to be given an assessment using the MSEL administered by a nurse. Only if scoring below the cutoffs for the MSEL would the child be referred to an appropriate specialist in the city, thus making the most efficient use of the scarce professional resources. Such a program should be evaluated in a subsequent research study.

CONCLUSION

This study provides evidence of the feasibility and usefulness of tools for developmental assessment and screening to be used in a semi-rural area in Africa. More easily usable tools need to be validated in such areas to screen and assess child development and cognitive and motor deficiencies. Given the cost of a visit for families and difficulties accessing healthcare, specificity and predictive values should be acceptable to be relevant for this population. After screening, more services should be available to take care of these children for early intervention.

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Abbreviations

EPDS	Edinburgh Postnatal Depression Scale
HOME	Home Observation for the Measurement of the Environment
MiPPAD	Malaria in Pregnancy Preventive Alternative Drugs
MSEL	Mullen Scales of Early Learning
NPV	Negative predictive value
PPV	Positive predictive value
RPM	Raven's progressive matrix
TQ	Ten Questions Questionnaire

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Table 1

Subjects' characteristics by gender

	Total	Boys	Girls	P-value
	N=357	N=180	N=177	
Standard Score MSEL	98.3 (13.6) ^a	96.9 (13.2)	99.7 (13.8)	.05
Visual reception	49.5 (10.8)	48.7 (10.8)	50.3 (10.8)	.14
Fine motor	49.7 (10.4)	48.7 (10.3)	50.6 (10.5)	.08
Receptive language	45.8 (6.5)	45.0 (6.7)	46.5 (6.2)	.02
Expressive language	51.0 (9.1)	50.6 (9.0)	51.3 (9.2)	.50
Gross motor	51.1 (15.0)	52.1 (15.8)	50.0 (14.1)	.18
Gross Motor Score minus 1 SD (39.7)				
No	263 (73.9%)	134 (74.4%)	129 (73.3%)	
Yes	93 (26.1%)	46 (25.6%)	47 (26.7%)	.80
Gross Motor Score minus 2 SD (29.3)				
No	339 (95.2%)	169 (93.9%)	170 (96.6%)	
Yes	17 (4.8%)	11 (6.1%)	6 (3.4%)	.23
Composite Score minus 1 SD (83.9)				
No	303 (84.9%)	152 (84.4%)	151 (85.3%)	
Yes	54 (15.1%)	28 (15.6%)	26 (14.7%)	.82
Composite Score minus 2 SD (68.5)				
No	348 (97.5%)	176 (97.8%)	172 (97.2%)	
Yes	9 (2.5%)	4 (2.2%)	5 (2.8%)	.75 ^b

^aMean and standard deviation^bFisher's exact test

Table 2

Pearson's correlation and associations between scores derived from MSEL and known risk factor for poor child development

	Composite Score	Gross Motor	Visual Reception	Fine Motor	Receptive Language	Expressive Language
Family wealth	0.12 *	0.17 **	0.12 *	0.06	0.11 *	0.05
HOME Inventory	0.20 ***	0.17 **	0.18 ***	0.12 *	0.14 **	0.15 **
Raven	0.16 **	0.15 **	0.21 ***	0.09 †	0.06	0.07 †
EPDS	0.01	-0.03	0.0006	0.03	0.07	-0.05

	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Maternal education						
No	96.3 (14.0) **	50.5 (14.5)	48.3 (10.8) *	48.6 (10.6) *	44.9 (6.5) *	50.0 (9.9) *
Yes	101.3 (12.5)	52 (15.7)	51.2 (10.5)	51.3 (10.0)	47.1 (6.2)	52.4 (7.4)
Maternal marital status						
Monogamous	99.1 (12.7) †	50.6 (14.9)	50.3 (10.5) †	50.5 (9.7) †	45.8 (6.6)	51.0 (8.8)
Polygamous	97.0 (14.9)	51.8 (15.1)	48.2 (11.1)	48.4 (11.4)	45.7 (6.3)	50.9 (9.5)

† *P-value* < .20

* *P-value* < .05

** *P-value* < .01

*** *P-value* < .001

Table 3

Association between scores derived from the MSEL and an appropriate subset of the TQ in 1-year-old Beninese children.

	Question 1	Question 4	Question 5	Question 6	Question 7	Question 8	Question 10
	Developmental milestones	Comprehension	Movement	Seizure	Learning	Speech	Intellectual impairment
	24.4% (87/356)	11.2% (40/356)	9.0% (32/356)	9.6% (34/356)	1.1% (4/356)	61.0% (217/356)	3.7% (13/356)
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Early Learning composite							
Negative question	99.7 (12.6) **	94.0 (14.7) *	99.2 (12.8) **	98.7 (13.4)	86.0 (14.7)	97.9 (14.1)	98.6 (13.2)
Positive question	93.7 (15.5)	98.8 (13.4)	88.5 (17.6)	94.5 (15.3)	98.4 (13.3)	98.9 (12.8)	88.9 (20.8)
Gross Motor							
Negative question	54.7 (14.4) ***	43.7 (14.0) ***	52.2 (14.6) ***	51.7 (15.0) †	50.5 (24.0)	50.1 (15.3)	51.6 (14.8) ***
Positive question	39.9 (10.6)	52.1 (14.9)	39.8 (14.8)	45.3 (14.0)	51.1 (14.9)	52.7 (14.3)	36.9 (12.6)
Visual Reception							
Negative question	50.2 (10.6) *	47.6 (10.6)	0.1 (10.3) ***	49.6 (10.7)	39.3 (15.9)	49.4 (10.8)	49.7 (10.6)
Positive question	47.1 (11.2)	49.7 (10.8)	43.1 (13.2)	48.3 (11.5)	49.6 (10.7)	49.5 (10.8)	44.8 (14.0)
Fine Motor							
Negative question	50.7 (9.8) **	47.6 (11.4)	50.5 (9.8) ***	49.8 (10.3)	42.3 (21.2)	49.6 (11.0)	49.9 (10.1)
Positive question	46.4 (11.8)	49.9 (10.3)	41.7 (13.3)	48.3 (11.8)	49.8 (10.3)	49.8 (9.5)	43.2 (15.0)
Receptive Language							
Negative question	46.1 (6.4) *	43.5 (8.0)	46.1 (6.3) **	46.0 (6.4) *	42.5 (17.1)	45.5 (6.6)	45.9 (6.3)
Positive question	44.5 (6.6)	46.0 (6.2)	42.4 (7.1)	43.5 (6.9)	45.8 (6.3)	46.0 (6.3)	42.5 (9.3)
Expressive Language							
Negative question	51.8 (8.4) **	47.8 (9.4) *	51.3 (8.9) *	51.3 (9.0) *	43.3 (15.5)	50.4 (9.5)	51.2 (8.8)
Positive question	48.1 (10.5)	51.3 (9.0)	47.5 (10.6)	47.9 (9.9)	51.0 (9.0)	51.8 (8.3)	44.2 (13.9)

† $P\text{-value} < .20$

* $P\text{-value} < .05$

** $P\text{-value} < .01$

*** $P\text{-value} < .001$

Table 4

Sensitivity, specificity, positive predictive value, and negative predictive value of some subsets of TQ among 1 -year-old Beninese children.

Cut-off 1: Mean minus 1 SD	Gross Motor				Composite score			
	Se ^a	Sp ^b	PPV ^c	NPV ^d	Se	Sp	PPV	NPV
Positive at TQ1	46.0 (35.8–56.9) ^e	83.0 (78.1–87.5)	49.0 (38.5–60.4)	81.0 (76.2–85.8)	40.7 (27.6–55)	78.5 (73.4–83)	25.3 (16.6–35.7)	88.1 (83.6–91.7)
Positive at TQ5	17.0 (10.2–26.4)	94.0 (90.3–96.5)	50.0 (31.9–68.1)	76.0 (71.1–80.7)	22.2 (12–35.6)	93.4 (90–95.9)	37.5 (21.1–56.3)	87.0 (82.9–90.5)
Positive on TQ1 OR positive on TQ5	47.3 (36.9–57.9)	80.5 (75.2–85.1)	46.3 (36–56.8)	81.2 (75.9–85.7)	42.6 (29.2–56.8)	76.2 (70.9–80.9)	24.2 (16–34.1)	88.1 (83.6–91.8)
Positive on at least 1 of the 9 questions	80.6 (71.1–88.1) ^g	31.3 (25.7–37.3)	29.4 (23.9–35.4)	82 (73.1–89)	81.5 (68.6–90.7)	30.1 (25–35.7)	17.3 (12.8–22.5)	90.1 (82.5–95.1)

Cut-off 2: Mean minus 2 SD	Gross Motor				Composite score			
	Se ^c	Sp ^d	PPV ^e	NPV ^f	Se	Sp	PPV	NPV
Positive on TQ1	76.5 (50.1–93.2)	78.0 (73.3–82.4)	15.0 (8.2–24.2)	99.0 (96.2–99.6)	66.7 (29.9–92.5)	76.7 (71.8–81)	6.9 (2.6–14.4)	98.8 (96.8–99.8)
Positive on TQ5	47.1 (23–72.2)	92.9 (89.6–95.4)	25.0 (11.5–43.4)	97.2 (94.8–98.7)	44.4 (13.7–78.8)	91.9 (88.5–94.6)	12.5 (3.5–29)	98.5 (96.4–99.5)
Positive on TQ1 OR positive on TQ5	76.5 (50.1–93.2)	75.7 (70.8–80.2)	13.7 (7.49–22.3)	98.5 (96.1–99.6)	77.8 (40–97.2)	74.6 (69.7–79.1)	7.4 (3.0–14.6)	99.2 (97.3–99.9)
Positive on at least 1 of the 9 questions	100 (80.5–100)	29.6 (24.8–34.8)	6.7 (3.93–10.5)	100 (96.4–100)	100 (66.4–100)	29.1 (24.4–34.2)	3.5 (1.63–6.59)	100 (96.4–100)

^aSensitivity

^bSpecificity

^cPositive predictive value

^dNegative predictive value

^eConfidence interval