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► **To cite this version:**

Roméo Zoumenou, Jaqueline Wendland, Victoria Jacobsen, Michael Boivin, Nathalie Costet, et al.. How Do Neurocognitive Tests Relate to Reported Child Difficulties at 6 Years of Age in Benin?. Archives of Clinical Neuropsychology, 2025, pp.acaf029. <10.1093/arclin/acaf029>. <hal-05034476>

HAL Id: hal-05034476

<https://ehesp.hal.science/hal-05034476v1>

Submitted on 22 Apr 2025

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How Do Neurocognitive Tests Relate to Reported Child Difficulties at 6 Years of Age in Benin?

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Abstract

Objective: The aim of this study was to examine the relationship between children's difficulties perceived by parents in the Ten Questions questionnaire (TQ) and children's assessments by the Kaufman Assessment Battery for Children, Second Edition (KABC-II) and the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2).

Methods: The study was carried out in the district of Allada, a semi-rural area of Benin, involving a cohort of 562 6-year-old children. A response was considered positive if the parent reported a difficulty for their child compared to other children.

Results: The proportion of TQ-reported difficulties was 34.2%. More difficulties were reported by parents when their child had lower scores on the KABC-II ($p < 0.001$) and on the BOT-2 ($p < 0.01$). Greater family wealth, higher maternal education, and better child school attendance were associated with higher KABC-II Mental Processing Index (MPI) scores, higher BOT-2 scores, and fewer reported difficulties on the TQ. The likelihood of parents reporting difficulties was >60% when KABC-II MPI scores were low. When considering the KABC-II as the gold standard to define mild delays (mean minus 1 SD), the TQ demonstrated a sensitivity of 51.0% and specificity of 69.4%, which increased to 58% and 72%, respectively, when children attended school.

Conclusion: Objective assessments of children's abilities were associated with parents' perceived difficulties. In a low-resource rural setting in sub-Saharan Africa, the TQ is a useful tool for screening neurodevelopmental difficulties, particularly for children attending school.

Keywords: Africa; Bruininks-Oseretsky test for motor proficiency; Child development; Kaufman assessment battery for children; Neuropsychology; Public health; Ten questions questionnaire.

FUNDING

Financial Support Data collection costs were supported by funding from the Fondation de France, France (00100075) to F.B-L

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Key words: Ten Questions Questionnaire, Kaufman Assessment Battery for Children, Bruininks-Oseretsky Test for Motor Proficiency, Neuropsychology, Child Development, Africa, Public Health.

Introduction

It is estimated that more than 200 million children in low- and middle-income countries (LMICs) fail to reach their full cognitive developmental potential (Black et al., 2017; Grantham-McGregor et al., 2007). To improve children's development, a clear understanding of the risk factors and mechanisms involved is necessary. For this, tools to evaluate child neurodevelopment are needed in LMICs.

Easy-to-use screening tools are very useful in LMICs and serve as a first step toward more in-depth evaluations of children's performances or abilities. For instance, the Ten Questions questionnaire (TQ) was designed to screen for disabilities in children aged 2 to 9 years. It is a rapid and low-cost screening tool for identifying children's disabilities in low-income countries. However, little is known about how children's performance relates to the child's difficulties reported by caregivers. This information would be crucial for better interpreting test results and efficiently guiding families to more advanced care.

In Benin, we conducted a large birth cohort study enrolling more than 1,000 pregnant women before 28 weeks of gestation (Gonzalez et al., 2014) and following their offspring with detailed long-term neurodevelopmental assessments at one and six years of age to identify risk factors for poor child neurodevelopment. Since 2011, we used validated tests, including the Mullen Scales of Early Learning (MSEL) and the Kaufman Assessment Battery for Children, 2nd edition (KABC-II), for which we first checked construct validity (Bodeau-Livinec et al., 2019) and demonstrated their predictive validity between one and six years (Boivin et al., 2021). Each of these tests has been validated in children in sub-Saharan Africa (SSA) studies (Chernoff et al., 2018). When using these tests, there is a need to provide adequate and meaningful feedback

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3 to parents, especially in a context with a high prevalence of risk factors for poor child
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5 neurodevelopment. Developmental difficulties in this context are sometimes perceived by
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7 parents but are rarely assessed by neurocognitive tests that allow for an accurate diagnosis
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9 and adequate early remediation. Parental perceptions seem to be more consistent in
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11 determining mental health problems than neurocognitive developmental issues (Black et al.,
12
13 2017). Awareness of developmental difficulties is low, and traditional explanatory models are
14
15 widespread among parents, as well as a preference for traditional treatment options in cases
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17 of neurocognitive dysfunction (Abera, Robbins, & Tesfaye, 2015; Adebowale & Ogunlesi, 1999;
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19 Choudhry, Mani, Ming, & Khan, 2016). Some studies have shown that traditional beliefs and
20
21 cultural differences may influence parental perceptions (Poduska, 2000), especially in Africa
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23 (Adebowale & Ogunlesi, 1999). Therefore, a better understanding of what is meaningful to
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25 parents, based on their perceptions and the child's performance, is needed.
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35 In our Beninese cohort, we showed that the MSEL was highly correlated with the TQ in infants,
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37 at one year of age, but this correlation was not known in school-aged children. Therefore, the
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39 main objective of this study is to investigate the relationship between the neurocognitive
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41 performance of children at the age of 6 years and difficulties reported by caregivers. Our goal
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43 was to provide tools to assess children's motor and cognitive development and to screen for
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45 poor child development in a semi-rural setting in a French-speaking, low-income African
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47 country. We hypothesized that the difficulties in cognitive and motor development perceived
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49 by parents in their 6-year-old children collected with the Ten Questions questionnaire (TQ)
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51 would be associated with children's performance assessed with two neurocognitive tests, the
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53 Kaufman Assessment Battery for Children-II (KABC-II) and the Bruininks-Oseretsky Test-2
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55 (BOT-2) (Boivin et al., 2007). More specifically, we hypothesize that overall, KABC-II
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3 performance will be most strongly related to the TQ domains related to cognitive function
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5 (understanding, learning, speech, language, intellectual ability). In addition, we hypothesize
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7 that BOT-2 will be most strongly related to the TQ domains related to motor function (motor
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9 ability and movement).
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17 **Methods**

18 **Study design and data collection procedure**

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20 This research is carried out as part of a longitudinal evaluation of a cohort of children recruited
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22 in Benin, West Africa. The study population consisted of children (N=963) born to mothers
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24 who were included in a cohort from 2009 to 2010 during the second trimester of their
25
26 pregnancy and followed in a trial that compared two intermittent preventive treatments for
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28 malaria (Sulfadoxine-Pyrimethamine and Mefloquine) (Gonzalez et al., 2014). Pregnant
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30 women were rigorously monitored until delivery, as were their offspring from birth to one
31
32 year. Of these, 747 one-year-old children were assessed at the psychomotor level between
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34 2011 and 2013 (Mireku et al., 2015), with the main objective being to study the impact of
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36 maternal anemia during pregnancy and its effect on child development at one year of age. At
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38 six years of age, children were invited to the clinic for assessment. At the clinic, 580 of these
39
40 children were assessed in a quiet room alone with the examiner (Garrison et al., 2022). Only
41
42 562 children could be assessed with all tests on the same day and were retained for the study.
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44 Assessment included the Kaufman Assessment Battery for Children, Second Edition (KABC-II)
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46 and the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2), the Test of
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48 Variables of Attention (TOVA), the Strengths and Difficulties Questionnaire (SDQ), and the Ten
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50 Questions questionnaire (TQ). These tests were administered to assess the child's cognitive
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3 development, motor development, attention deficits and hyperactivity, behavior, and
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5 parents' perceived difficulties, respectively. Although the tests were provided in French to the
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7 evaluators, the instructions were given to the child and mother aloud in a local Benin language
8
9 (Fon). The evaluators were psychologists and nurses trained to administer these different
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11 tests. In case of fever or illness, children were tested for malaria and anemia and treated if
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13 necessary. They were invited for psychological assessment only in the absence of symptoms.
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20 **Kaufman Assessment Battery for Children, Second Edition (KABC-II).**

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22 The KABC-II provides a comprehensive assessment of neurocognitive and psychological
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24 abilities in children up to 13 years of age, according to the French version, and has been
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26 adapted and validated in malaria studies involving African children in Uganda (Boivin et al.,
27
28 2007) and in Benin during a pilot study (Koura et al., 2013). It comprises five cognitive domains:
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30 sequential processing, simultaneous processing, learning, planning, and knowledge (Kaufman
31
32 A, 2004). Apart from the Mental Process Index (MPI), which provides an overall level of
33
34 executive functioning, the KABC-II also produces a Non-Verbal Index (NVI). This French version
35
36 is exclusively published and distributed by Éditions du Centre de Psychologie Appliquée (ECPA par
37
38 Pearson) with the permission of AGS Publishing, Pearson Products Inc., with standards
39
40 developed based on the French population. To ensure the quality of the assessments, a
41
42 monthly independent evaluation of each interviewer was carried out (Garrison et al., 2022).
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44 Mild and moderate delays were defined as the mean from the population minus 1 and 2
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46 Standard Deviations, respectively.
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57 **Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2)**

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3 The BOT-2 is a standardized test that provides a comprehensive measure of gross and fine
4 motor skills in children (Bruininks, 2005). BOT-2 total scores (0-72) are age-standardized to US
5 norms and applied as such to children in Benin.
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10 11 12 13 **Ten Questions questionnaire (TQ)** 14

15 The TQ is a short, easy-to-use questionnaire that asks the caregiver to compare the child with
16 other children of the same age regarding developmental difficulties or disabilities the child
17 may have (Durkin et al., 1994). For example it was asked to the caregiver: "Compared with
18 other children of his or her age, does the child appear in any way mentally backward, dull, or
19 slow?". It is a tool for screening children for neurological impairments and disabilities. This
20 screening questionnaire, validated in other studies, is commonly used in low- and middle-
21 income countries (Kakooza-Mwesige et al., 2014) and has been validated for the children in
22 this cohort at one year of age (Koura et al., 2013). The TQ is administered to children aged 2-
23 9 years and is an effective screening tool for identifying cognitive, motor, sensory, and seizure
24 disorders in children in low-resource environments (Mung'ala-Odera et al., 2004). It takes little
25 time to administer and is typically done in a face-to-face interview. It has been used in
26 numerous studies in several countries and provides information on children's
27 neuropsychological development.
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46 In this study, the child's caregiver was asked to compare the child with other children of the
47 same age and list difficulties in terms of vision, hearing, behavioral difficulties, and cognitive
48 and motor development. The TQ was used and translated into French and Fon in this cohort
49 when children were one year of age (Koura et al., 2013). The same translation was used for
50 the present study at six years of age. We selected specific questions from the TQ that were
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3 closely related to the KABC-II and the BOT-2. Screening with the TQ is considered positive if at
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5 least one difficulty is reported in any of the ten questions.
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10 **Socio-economic status**

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12 In our study, two variables were used to assess family socio-economic status: the family's
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14 wealth and the mother's level of education (Mung'ala-Odera et al., 2004) at the time of child
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16 assessment. The family wealth scale was described in another study on this same cohort of
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18 children (Koura et al., 2013) and was assessed using scoring items that included a checklist of
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20 family material possessions (radio, television, bicycle, motorcycle, and car), cow ownership,
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22 and access to electricity. Maternal education was categorized based on whether mothers had
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24 received some schooling, at least at the primary school level.
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32 **Statistical analysis**

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34 The statistical analysis included a description of the socio-demographic characteristics of the
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36 children and their mothers. Various child measures were summarized with means and
37
38 standard deviations for continuous variables, and percentages for categorical variables.
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40 Maternal education (yes/no), child sex (boy/girl), and child education at the time of
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42 assessment (yes/no) were binary variables. Bivariate analyses were performed between some
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44 of these variables, which are known risk factors for poor child neurocognitive development,
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46 and a subset of the TQ. Associations between KABC-II and BOT-2 composite scores and
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48 selected subsets of the TQ were examined. Relevant questions from the TQ were selected for
49
50 each test. Based on the similarities found between certain TQ questions and the
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52 neurocognitive and psychomotor assessment tests used, we investigated potential
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54 relationships. As a result, six of the TQ questions were studied in relation to the KABC-II, and
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3 two in relation to the BOT-2, to analyze possible associations. TQ questions 1 (Motor ability)
4 and 5 (Movement), relating to motor difficulties, as well as TQ questions 4 (Understanding), 7
5 (Learning), 8 (Speech), 9 (Different language), 10 (Intellectual ability), and 12 (Hearing),
6 relating to neurocognitive development, were studied for associations between BOT-2, KABC-
7 II and TQ. Means, standard deviations, and predictive values of a TQ subset associated with
8 KABC-II and BOT-2 composite scores were calculated. Finally, these analyses were computed
9 in relation to at least one TQ difficulty reported. Scatterplots were created to illustrate the
10 probability of a positive screening score according to the KABC-II scores. Logistic regression
11 was used to predict parents' responses to the TQ based on the KABC-II scores to explore
12 whether low KABC-II scores were predicted by parents' answers. All statistical analyses were
13 performed using SAS 9.4 software, and statistical tests were two-tailed. A p-value < 0.05 was
14 deemed significant.
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35 **Ethical and data protection procedures**

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37 The EXPLORE study protocol was approved by the local Research Ethics Committee
38 Committee of Ethical Research of the Applied Biomedical Sciences Institute (CER-ISBA) in
39 Benin (#87). Written informed consent was obtained at the clinic or thumbprints were
40 provided for consent if the caregiver could not read or write. Treatment for malaria,
41 helminths infections and anemia was given if relevant. Recommendations regarding lead
42 exposure was given.
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54 **Results**

55 **General description**

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3 Of the 963 live singleton births to mothers participating in the clinical trial, 562 children were
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5 evaluated with data available for the KABC-II, BOT-2 and TQ, and are included in our analyses.
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8 The mean age was 6.5 years (standard-deviation: 0.47, age range: [4.0-8.7]). A total of 293 boys
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10 (52%) and 269 girls (48%) underwent comprehensive assessments with all relevant tests. The
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12 characteristics of children by sex, as assessed by the KABC-II and BOT-2 composite scores, are
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14 presented in Table 1. Boys presented higher score of KABC-II sequential processing scores,
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16 delayed recall scores, and BOT-2 standardized scores compared with girls
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23 **Socioeconomic status and child neurodevelopment (Tables 2 and 3)**

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25 A large proportion of mothers had no schooling (64%). Additionally, one-third of children were
26
27 not attending school. As expected, greater family wealth, higher maternal education, and
28
29 better child's school attendance were statistically associated with higher scores on the KABC-
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31 II, the BOT-II, and fewer positive responses on the TQ. Maternal marital status was not
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33 associated with KBAC-II, BOT-II, or TQ. Gender was not associated with TQ (p-value: 0.45).
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40 **Association of KABC-II and BOT-II derived scores with the TQ (Tables 4 and 5).**

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42 Some TQ scores were associated with KABC-II (Table 4), and others with BOT-2 scores (Table
43
44 5). Overall, 34.2% of parents reported at least one difficulty for their child (positive TQ). The
45
46 mean KABC-II scores, including the standardized Mental Processing Index (MPI), the global
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48 MPI, the standardized sequential processing score, the standardized learning score, the
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50 standardized delayed recall score, and the standardized non-verbal index, were lower when
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52 the TQ was positive, compared to when parents did not report any difficulties for their child
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54 (p<0.001). These associations were particularly strong for the questions related to the child's
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56 speech (question 8) and intellectual ability (question 10). The mean BOT-II scores were
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3 associated with the question related to motor ability (question 1, $p=0.002$) and with the
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5 overall TQ ($p=0.01$), as shown in Table 4.
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10 **Probability to report a positive TQ according to KABC-II scores, sensitivity and specificity**
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12 **(Figures 1 and 2, Table 6)**

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15 The probability of parents reporting a difficulty was higher than 50% when KABC-II scores were
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17 lower (Figure 1). The probability was higher among children attending school compared with
18
19 those not attending school (Figure 2), but it was very close between girls and boys. When
20
21 considering the KABC-II as the gold standard to define mild delays (mean from the population
22
23 minus 1 SD), the probability of a positive report was 51.1%, reaching 57.6% when children
24
25 were attending school. The sensitivity, specificity, positive predictive, and negative predictive
26
27 values were 51.0%, 69.4%, 26.3%, and 86.9%, respectively. When considering the KABC-II as
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29 the gold standard to define moderate delays (mean from the population minus 2 SD), the
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31 probability was 80.0%. However, only 10 children were included in the moderate delay
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33 category.
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42 **Sensitivity analyses.**

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44 One child was 4 years of age, and 3 were 5 years of age. In addition, 13 and 21 children were 7 and 8
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46 years of age, respectively. When excluding children below 5.5 and children above 7 years of age, results
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48 were unchanged. When stratifying on gender, the same associations were found between TQ and
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50 KABC-II derived scores. The only difference was in girls where the association between TQ and NVI did
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52 not reach significance (p -value=0.12).
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Discussion

The aim of this study was to examine the relationship between parents' perceived difficulties, as reported in the Ten Questions questionnaire (TQ), and children's performance on the Kaufman Assessment Battery for Children, 2nd Edition (KABC-II) and the Bruininks-Oseretsky Test of Motor Proficiency, 2nd Edition (BOT-2). We observed a strong association between the parents' reports and the neurocognitive performance-based assessments of the children in this cohort. To our knowledge, this is the first study to investigate the relationship between parents' reports and actual assessments of children's performance in such a large study in SSA. We found that 34.2% of parents reported at least one difficulty on the TQ. This is consistent with a study conducted in Uganda where 27% of children screened positive (Kakooza-Mwesige et al., 2014).

Associations on motor questions

There was a significant association with the BOT-2 and questions 1 (Motor ability) and 5 (Movement) of the TQ. These results are comparable to those of a study conducted in Benin on this same cohort of one-year-old children, which showed the association of these two questions with the motor functions of the MSEL (Koura et al., 2013). However, the associations for motor functions appeared weaker than those for cognitive outcomes. These difficulties may be harder for parents to detect unless they are more pronounced.

Socio-demographic conditions

Boys scored higher than girls on some cognitive tasks. Studies have shown that, apart from sex, children's family wealth, environment, and education were significantly correlated with the raw, standardized measure of global cognitive performance on the KABC-II and MPI

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3 (Bodeau-Livinec et al., 2019; Boivin et al., 2021). Family wealth was also associated with higher
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5 scores on the receptive language scale (Koura et al., 2013).
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10 **Difficulties reported**

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12 Analysis of the TQ items, combined with the KABC-II and BOT-2, revealed that the TQ was
13
14 effective in detecting difficulties in children. Significant associations were found between TQ-
15
16 reported difficulties and neurocognitive test scores. The TQ screen is considered positive if
17
18 any of the questions is answered affirmatively. When children are not attending school, many
19
20 parents have fewer benchmarks to gauge their children's neurocognitive development
21
22 (Mung'ala-Odera et al., 2004). Indeed, the TQ asked parents to compare their child with others
23
24 of the same age. These children share similar socio-economic and cultural conditions, meaning
25
26 the children being compared are likely to have similar risk factors for poor development.
27
28 Parents have more reference points for comparison when children are in school. The
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30 probability of TQ-reported difficulties increases with very low KABC-II and BOT-2 scores, and
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32 exceeds 50%. These results may be influenced by socio-cultural and economic factors,
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34 including the high number of children not attending school, limited access to external
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36 influences (such as media), and parents' lack of awareness about developmental and
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38 neurocognitive disabilities. However, the cutoff used in our population was the mean minus
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40 one standard deviation, which is not considered indicative of developmental delay, but may
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42 include some children with difficulties. Therefore, these results are consistent with what might
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44 be expected.
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55 **Usefulness of TQ screen**

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3 The validity of the TQ has been extensively studied in Africa and around the world, including
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5 countries such as Bangladesh, Jamaica, Pakistan, Saudi Arabia, Ghana, South Africa, and Kenya
6
7 (Mung'ala-Odera et al., 2004) for children aged 2 to 9 years. A previous study showed the
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9 validity of the TQ in the children in this cohort when they were one year old. The results
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11 revealed a high number of false-positive results (Koura et al., 2013). However, the TQ was
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13 significantly associated with the Mullen Scales of Early Learning at one year of age. Compared
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15 to results in the same children at one year of age, the TQ sensitivity was lower at six years
16
17 (81.5% at one year versus 51.0% at six years), but the specificity was higher (30.1% at one year
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19 versus 69.4% at six years). With the TQ, caregivers are asked to compare their children with
20
21 other children. In a setting with high prevalence of risk factors for developmental problems, it
22
23 may be difficult for caregivers to detect problems for their children. This may explain the
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25 differences in sensitivity and specificity between one and six years of age. These results, with
26
27 less false-positives, are particularly important in this low-resource setting.
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37 In a study of children aged 6 to 9 years conducted in Kenya, the TQ was found to be sensitive
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39 to visual and hearing impairments but not sensitive to cognitive disorders (Bitta et al., 2021),
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41 and could even underestimate child development. Another study in Bangladesh found that a
42
43 good validity of the TQ to screen disabilities in 10-16 year old children in relation to the
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45 Wechsler Intelligence Scale-Revised (WISC-R) assessments by psychologists as a reference
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47 standard (Hasan et al., 2023).
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54 By combining the scores from the KABC-II and the BOT-2 with the TQ, the results showed that
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56 parents whose children had low KABC-II or BOT-2 reported more difficulties in their children
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58 on the TQ. This association highlights the value of the tests in detecting difficulties in children.
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3 The TQ can be used to identify developmental delays, which can serve as an indicator of
4 disability. These results are consistent with studies conducted in Uganda, Bangladesh,
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6 Pakistan, and Jamaica, which also used the TQ to screen for cognitive impairments in children
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8 aged 2-9 years (Durkin et al., 1994). It can be inferred that the TQ-positive children identified
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10 in this study represent minimum estimates, as the TQ reliably detects only moderate and
11
12 severe disabilities, not mild conditions (Mung'ala-Odera et al., 2004).
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20 The standardized scoring of such “western-based” tests necessitates the use of norms from
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22 children in American (KABC in English) or European (KABC in French) countries to adjust the
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24 scale performance for age. This is because country-specific norms are typically not available
25
26 for the low- and middle-income countries (LMICs) in which the KABC is used. Although the
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28 resulting standardized scores for African children on the KABC are typically below that of the
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30 normative means devised for those measures, the factor structure and construct validity of
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32 the test itself remains intact (Bangirana P, 2009). Boivin and Giordani (2009) have suggested
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34 that this is because tests such as the KABC can provide a reasonable and valid characterization
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36 of neuropsychological brain/behavior integrity in African children because of the more
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38 universal features of the foundational neurocognitive skills and abilities derived from this
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40 foundational brain/behavior “omnibus” (Boivin & Giordani, 2009).
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50 Children identified by the TQ as being at risk of disability could be referred for evaluation using
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52 more in-depth diagnostic measures (MSEL, KABC-2, BOT-2, etc.) to benefit from specific
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54 psychiatric, neurological, neurocognitive, or neurodevelopmental treatments (Lorencz EE,
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56 2013). Especially, the abilities related to language and overall learning disability were highly
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58 correlated to TQ, and may be of great importance for parents, and should be detected and
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3 treated. In this population, where resources are scarce and access to care is limited, these
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5 tests are essential and easy to use.
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10 **Limitations**

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12 Although the results of this study are encouraging and demonstrate a significant association
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14 between the KABC-II, BOT-2, and TQ, there are limitations to be addressed. It is important to
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16 note that the sample of children evaluated is not nationally representative, as it consists only
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18 of parents and children living in a semi-rural region. This population faces high illiteracy rates,
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20 and socio-economic and cultural conditions differ from those in developed countries.
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25 A total of 747 children were assessed at 12 months of age, but only 562 were assessed at six
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27 years of age. This attrition is attributed to loss to follow up and high mortality rates. Children
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29 lost to follow-up tended to come from slightly more disadvantaged families. While this may
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31 slightly underestimate the proportion of positive TQ results, it is unlikely that the observed
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33 associations were significantly affected.
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38 We used standardized scores for both the KABC-II and BOT-2. The scores in our study were
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40 relatively low and should be interpreted with caution, as no local standardization exists for
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42 Benin. Using Western norms may not be optimal, especially regarding age standardization
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44 (Bodeau-Livinec et al., 2019). However, since our study compared children within the same
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46 population, all of whom were of same age, this limitation is minimized. Furthermore, we
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48 determined the cutoff for mild cognitive deficits according to the mean and standard deviation
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50 within our population.
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55 Despite having a large sample size, only ten children (1.8%) fell into the category for moderate
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57 delay (KABC-II MPI mean minus two standard deviations). This aligns with expectations, but
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3 sensitivity and specificity could not be calculated for this group due to the small number of
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5 children in this category.
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8 Children were also assessed the Test of Variables of Attention (TOVA) and the Strengths and
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10 Difficulties Questionnaire (SDQ). These tests were not included in the analyses as they
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12 measure other dimensions. These two other dimensions, including an objective assessment
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14 (TOVA) of children's abilities and one reported by parents (SDQ) were also associated
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16 (Zoumenou, Costet, Boivin, Wendland, & Bodeau-Livinec, 2025).
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20 Finally, this study is large, with trained interviewers and standardized tests. A qualitative
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22 survey could complement this work by providing deeper insights into parents' perceptions of
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24 their child's development.
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30 **Conclusion**

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32 In this study, the TQ was significantly associated with both motor development and
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34 neurocognitive assessments. As a screening tool, the TQ could help identify children who
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36 would benefit from early intervention, ultimately contributing to the development of the
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38 countries concerned. The TQ is easy to use, requires few resources, and could be integrated
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40 into routine primary care for children in areas at risk for poor cognitive development.
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3 **Table 1: Sample characteristics by sex according to KABC-II & BOT-II composite scores**

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5 **Table 2: Association between KABC-II MPI and BOT-2 and known risk factors for poor child development.**

6 The mean and standard deviation are presented for each of the descriptive categorical measures
7 in the table below for the KABC-II and for the BOT-II.

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10 **Table 3: Association between TQ-reported difficulties reported and known risk factors for poor child**
11 **development**

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13 **Table 4: Association between KABC-II derived scores and an appropriate subset of the TQ**

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15 **Table 5: Associations between BOT-II derived scores and an appropriate subset of the TQ**

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17 **Table 6. Sensitivity, specificity, positive and negative predictive values of at least one TQ-reported**
18 **difficulty (positive TQ) according to level of KABC-II global MPI.**

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21 **Figure 1: Probability of TQ-reported difficulties according to Standardized Mental Processing Index (MPI) (A),**
22 **global MPI (B) and non-verbal index (C) on KABC-II**

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26 **Figure 2: Probability of TQ-reported difficulties according to global MPI on KABC-II among children going to**
27 **school (A), and among children not going to school (B)**

Table 1: Sample characteristics by sex according to KABC-II & BOT-II composite scores

	Total	Girls	Boys
	N= 562	N= 269	N= 293
	Mean (SD)	Mean (SD)	Mean (SD)
KABC-II standardized Mental Processing Index (MPI)	60.3 (12.1)	59.2 (12.1)	61.2 (12.0) †
KABC-II global Mental Processing Index (MPI)	39.3 (12.0)	38.4 (12.3)	40.1 (11.7) †
KABC-II standardized sequential processing global score	79.8 (15.0)	78.0 (14.5)	81.4 (15.2) **
KABC-II standardized simultaneous processing global score	55.5 (9.8)	55.2 (9.7)	55.7 (10.0)
KABC-II standardized learning global score	76.8 (12.7)	75.7 (12.8)	77.7 (12.6) †
KABC-II standardized delayed recall global score	77.9 (12.0)	76.5 (11.7)	79.1 (12.2) **
KABC-II standardized non-verbal index (NVI)	51.8 (7.7)	51.8 (7.8)	51.9 (7.5)
Bruininks-Oseretsky Test, Second Edition (BOT-II) of Motor Competence			
BOT-II standardized total score	39.4 (9.2)	35.2 (7.3)	43.3 (9.0) ***

Note : *p-value < .05; **p-value < .01; ***p-value < .001; †p-value < .20.

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Table 2: Association between KABC-II MPI and BOT-2 and known risk factors for poor child development. The mean and standard deviation are presented for each of the descriptive categorical measures in the table below for the KABC-II and for the BOT-II.

		KABC-II Standardized Mental Processing Index (MPI)		BOT-2	
Family wealth		0.23	<0.001***	0.12	<0.01**
	% (n)	Mean (SD)	P-value	Mean (SD)	P-value
Maternal education			<0.001***		0.01*
	Education	36.0 (209)	63.6 (12.1)	40.6 (8.8)	
	No Education	64.0 (353)	58.3 (11.6)	38.6 (9.2)	
Marital status of mother			0.46		0.26
	Monogamous	51.5 (266)	59.7 (12.6)	38.8 (9.1)	
	Polygamous	48.5 (251)	60.5 (11.4)	39.8 (9.3)	
Child is going to school			<0.001***		<0.001***
	No going to school	32.6 (181)	63.7 (12.0)	41.6 (8.9)	
	Going to school	67.4 (374)	53.0 (8.5)	34.6 (7.5)	

Note : *p < .05; **p < .01; ***p < .001; †p < .20.

Table 3: Association between TQ-reported difficulties reported and known risk factors for poor child development

	TQ-reported difficulties	
Family wealth	-0.14	0.001**
	%	P-value
Maternal education		<0.01**
Education	27.3%	
No Education	38.5%	
Marital status of mother		0.83
Monogamous	33.1%	
Polygamous	34.0%	
Child is going to school		<0.01**
No going to school	30.0%	
Going to school	42.5%	

Note : *p < .05; **p < .01; ***p < .001; †p < .20.

Table 4: Association between KABC-II derived scores and an appropriate subset of the TQ

	Question 4 Understanding	Question 7 Learning	Question 8 Speech	Question 9 Different language	Question 10 Intellectual disability	At least one TQ -reported difficulty
	5.6% (31/554) Mean (Std. Dev)	4.0% (22/555) Mean (Std. Dev)	4.5% (25/555) Mean (Std. Dev)	10.1% (56/555) Mean (Std. Dev)	15.9% (88/555) Mean (Std. Dev)	34.2% (190/555) Mean (Std. Dev)
Standardized Mental Processing Index (MPI)	†		***	†	***	***
No TQ-reported difficulties	60.4 (12.2)	60.3 (12.0)	60.7 (12.1)	60.5 (12.1)	61.4 (12.0)	62.1 (12.1)
TQ-reported difficulties	56.3 (9.6)	57.7 (14.8)	50.0 (7.4)	57.4 (12.2)	53.7 (10.6)	56.6 (11.2)
Global Mental Processing Index (MPI)	*		***	*	***	***
No TQ-reported difficulties	39.5 (12.1)	39.4 (11.8)	39.8 (11.9)	39.6 (11.9)	40.4 (11.9)	41.1 (11.9)
TQ-reported difficulties	34.6 (11.0)	34.7 (17.1)	27.4 (10.2)	35.9 (13.0)	33.2 (11.2)	35.6 (11.6)
Standardized Sequential processing score	†		***	†	***	***
No TQ-reported difficulties	79.9 (14.8)	79.8 (14.7)	80.2 (14.8)	80.1 (14.8)	81.0 (14.8)	81.6 (14.6)
TQ-reported difficulties	75.4 (16.6)	77.1 (21.6)	68.3 (14.8)	76.5 (16.5)	72.6 (13.9)	76.0 (15.0)
Standardized Simultaneous processing score	**		**	*		
No TQ-reported difficulties	55.6 (9.9)	55.5 (9.6)	55.7 (9.8)	55.7 (9.9)	55.4 (9.5)	55.7 (10.0)
TQ-reported difficulties	51.9 (6.2)	53.6 (12.1)	50.1 (7.2)	52.9 (8.1)	55.5 (10.9)	54.9 (9.3)
Standardized Learning score	**	†	***		***	***
No TQ-reported difficulties	77.1 (12.8)	77.0 (12.4)	77.3 (12.6)	77.0 (12.6)	77.9 (12.6)	78.5 (12.6)
TQ-reported difficulties	70.4 (10.9)	71.5 (19.1)	65.3 (11.3)	74.9 (13.6)	70.8 (12.1)	73.3 (12.3)
Standardized Delayed Recall score	*	†	**		*	***
No TQ-reported difficulties	78.2 (12.0)	78.1 (11.8)	78.3 (11.8)	78.0 (12.0)	78.8 (12.1)	79.3 (12.2)
TQ-reported difficulties	73.6 (10.6)	73.4 (15.2)	69.1 (10.9)	77.1 (11.7)	73.2 (10.1)	75.2 (11.1)
Standardized Non-Verbal Index (NVI)			***	*	***	***
No TQ-reported difficulties	51.9 (7.7)	51.9 (7.6)	52.1 (7.7)	52.1 (7.8)	52.4 (7.7)	52.6 (8.1)
TQ-reported difficulties	51.1 (7.7)	51.0 (9.6)	45.9 (4.7)	49.6 (6.8)	49.0 (6.6)	50.4 (7.0)

Note : *p < .05; **p < .01; ***p < .001; †p < .20.

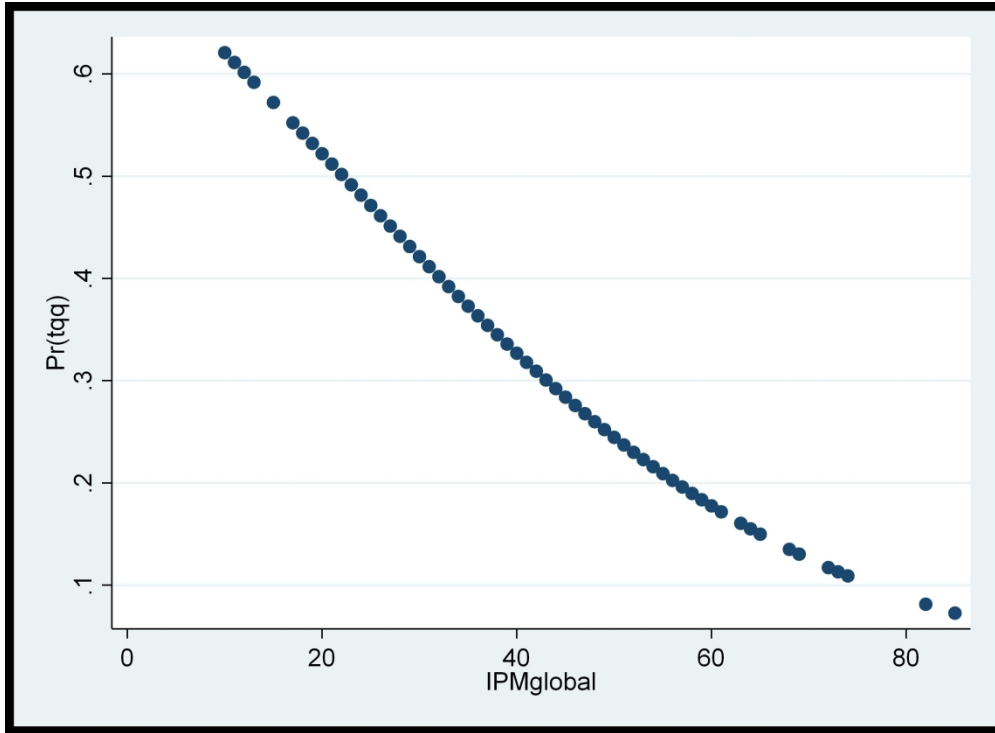
Table 5: Associations between BOT-II derived scores and an appropriate subset of the TQ

	Question 1	Question 5	At least one TQ -reported difficulty
	Motor ability 6.0% (33/555)	Movement 2.3% (13/555)	34.2% (190/555)
	Mean (SD)	Mean (SD)	Mean (SD)
<hr/>			
BOT-II standardized total score.			
No TQ-reported difficulties	39.6 (9.0)	39.4 (9.1)	40.0 (8.9)
TQ-reported difficulties	34.4 (8.9)	34.8 (9.4)	37.9 (9.4)
P-value:	0.002**	0.09†	0.01**

Note : *p < .05; **p < .01; ***p < .001; †p < .20.

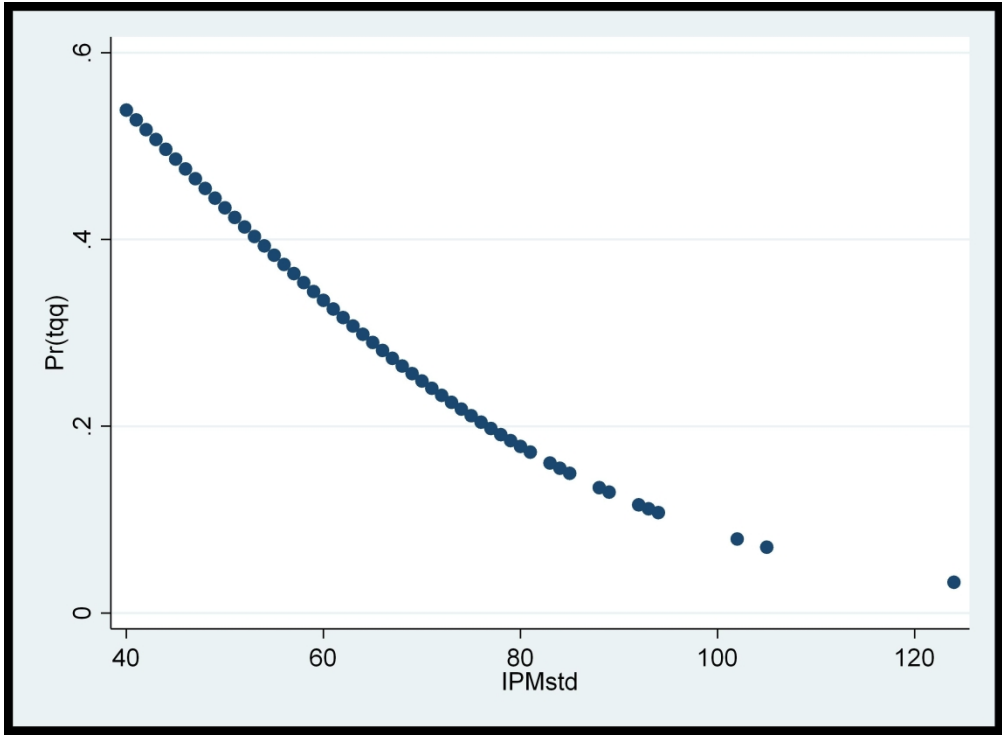
Table 6. Sensitivity, specificity, positive and negative predictive values of at least one TQ-reported difficulty (positive TQ) according to level of KABC-II global MPI.

	Global MPI < 27.3 (mean – 1 SD) (92/562=16.4%)						Global MPI < 15.3 (mean – 2SD) (10/562=1.8%)	
	Sensitivity % [95%CI]	Specificity % [95%CI]	Positive predictive value % [95%CI]	Negative predictive value % [95%CI]	Probability of TQ-reported difficulties	Probability of no TQ- reported difficulties	Probability of TQ-reported difficulties	Probability of no TQ- reported difficulties
Overall (N=562)	51.0 [41.1;60.9]	69.4 [65.1;73.6]	26.3 [20.0;32.6]	86.9 [83.4;90.3]	51.1%	30.1%	80.0%	33.4%
Child is going to school								
Not going to school (N=181)	46.6 [33.7;59.4]	59.4 [50.7;68.0]	35.1 [24.4;45.7]	70.2 [61.4;79.0]	46.6%	40.7%	60.0%	42.0
Going to school (N=374)	57.6 [40.7;74.4]	72.3 [67.9;77.4]	17.0 [10.1;23.9]	94.6 [91.9;97.4]	57.6%	27.4%	-	29.3%
Maternal education								
Education (N=199)	47.1 [23.3;70.8]	74.6 [68.2;80.9]	14.8 [5.3;24.3]	93.8 [89.8;97.7]	47.1%	25.4%	-	26.2%
No Education (N=353)	52.7 [41.3;64.1]	65.2 [59.6;70.8]	28.7 [21.1;36.3]	83.9 [79.0;88.8]	52.7%	34.8%	71.4%	37.9%



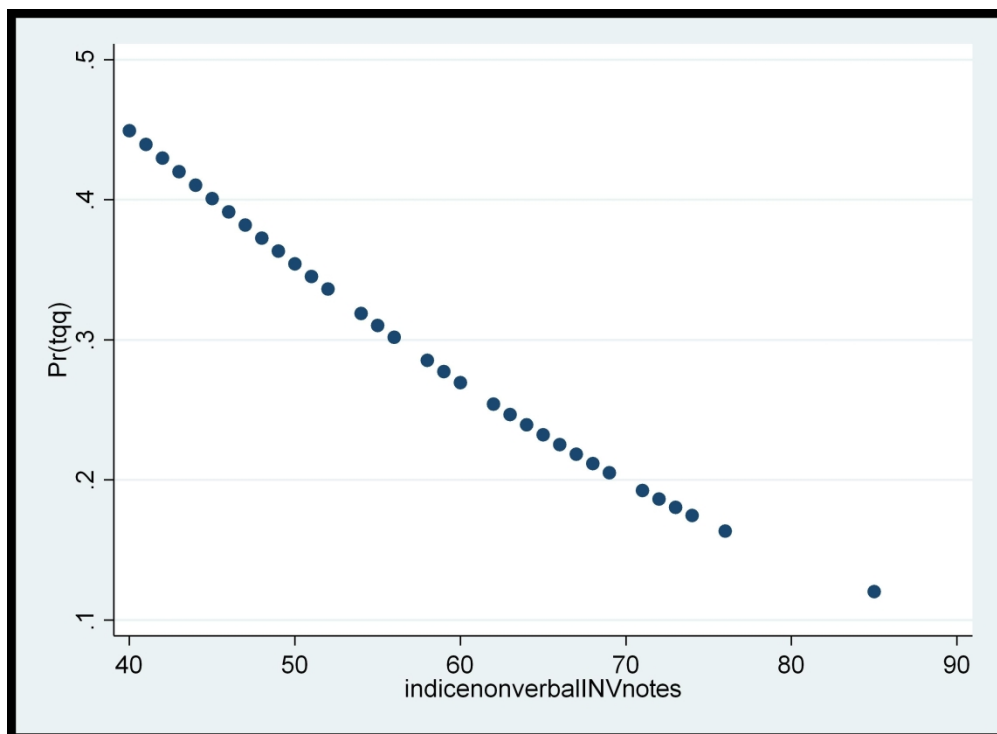
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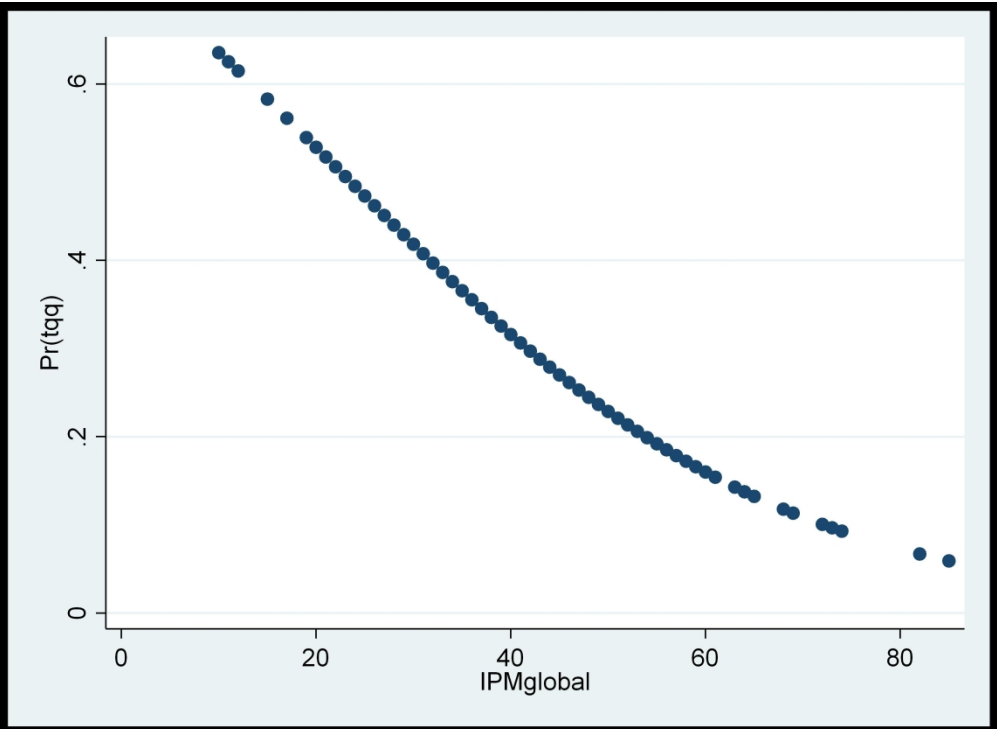
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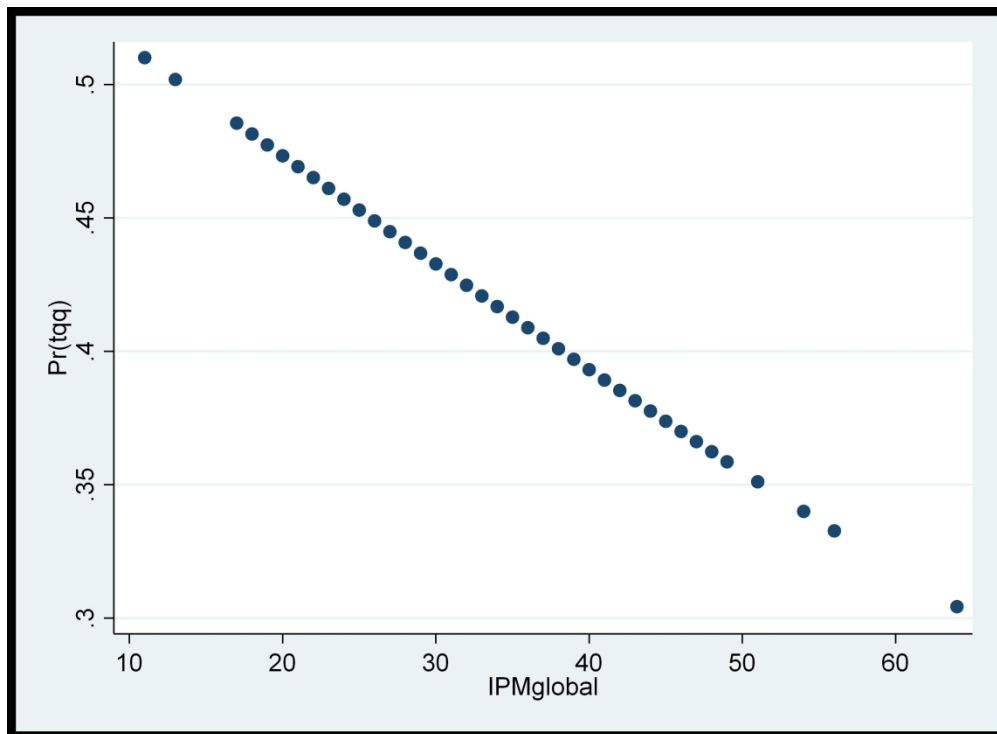
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STROBE Statement—checklist of items that should be included in reports of observational studies

Page in the manuscript		Item No	Recommendation
1/27	Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract
1/27			(b) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction			
3-4/27	Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
4/27	Objectives	3	State specific objectives, including any prespecified hypotheses
Methods			
5/27	Study design	4	Present key elements of study design early in the paper
5/27	Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
5/27	Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up
			<i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls
			<i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants
			(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed
			<i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case
6-8/27	Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
6-8/27	Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
	Bias	9	Describe any efforts to address potential sources of bias
5/27	Study size	10	Explain how the study size was arrived at
8/27	Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
8/27	Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding
8/27			(b) Describe any methods used to examine subgroups and interactions
			(c) Explain how missing data were addressed
			(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed
			<i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed

Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy

(e) Describe any sensitivity analyses

Page in the manuscript	Results		
9/27	Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram
9/27	Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)
	Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time <i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure
10/27			<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures
11/27	Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
12/27	Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion			
11/27	Key results	18	Summarise key results with reference to study objectives
14-15/27	Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
12-14/27	Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
15/27	Generalisability	21	Discuss the generalisability (external validity) of the study results
Other information			
	Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based