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Psychometric properties of (the) ages and stages questionnaire (ASQ-3) in a Colombian population

Abstract

The psychometric properties of the Ages and Stages Questionnaire, Third Edition (ASQ-3) in a Colombian population were explored, including construct validity and convergent validity. The ASQ-3, in its Spanish version, and the *Escala de Abreviada del Desarrollo* (Abbreviated Development Scale - EAD-3, by its acronym in Spanish) were compared. Participants included 456 children selected at random from live births in the time period between 2014 and 2018. Results indicated that the ASQ-3 yielded valid results when compared with the EAD-3. Implications include using the ASQ-3 for accurate screening, especially when children are identified with fine motor deficits on the EAD-3.

Keywords: ASQ-3, EAD-3, neurodevelopment, psychometric properties.

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Introduction

Neurodevelopment is defined as a dynamic and complex process in which the interaction of biological, psychological and social aspects progressively shape the abilities and competencies that will allow children to satisfactorily interact with their environment.[1] In this process, there are critical periods (the first two years of life) in which the foundational skills and abilities that serve as the prerequisites for more complex cognitive functions are consolidated, and during which the appearance of alterations may have a negative impact if not detected and treated promptly.[2,3] Various international organizations recommend early and periodic testing (i.e., at 9, 18, 30 and 48 months) with the aim of identifying delays in a children's neurodevelopmental processes and referring them to more specialized services in order to reduce further developmental problems.[2,4] Developmental problems are prevalent worldwide; the Bernard van Leer Foundation,[5] indicates that 25% of children in the world suffer from a growth delay; 200 million children in the world do not achieve their physical, cognitive, psychological and/or socio-emotional potential, due to factors related to poverty, poor health, deficient nutrition, and insufficient care and stimulation.

In Colombia, as in Latin America in general, there is no national registry to assist with universal developmental screening (i.e. measuring cognition, language, socio-emotional, motor skills). Instead, initiatives have been focused on reducing mortality and malnutrition.[6] In Colombia, government health services carry out a health evaluation and later follow up the development of boys and girls with the *Escala de Abreviada del Desarrollo* (Abbreviated Development Scale) (EAD-3, by its acronym in Spanish). Currently there are no national databases to guide public policy decisions related to improving children's developmental outcomes, nor to assist academic institutions in charge of investigating problems related to early childhood development.[7] Thus, conducting developmental screening in a structured and systematic manner, using standardized tests validated for the preschool Colombian population, would allow for evaluating early development and referring children for specialized services as needed. In addition, universal developmental screening would assist policy makers in gathering data to determine initiatives that would have the largest impact on improving children's outcomes.

In order to identify deviations in neurodevelopment early on, various screening tests have been used to assess a child's performance across domains (cognitive, socio-emotional, motor, etc.) and to refer them to specialized services when required. Researchers and policy makers have emphasized the need to use instruments that report optimal psychometric characteristics, such as reliability and validity to obtain more precise and contextualised measurements regarding child development.[8] The ASQ-3[9] has proven to be a valid instrument for the evaluation of development, which can be easily administered by caregivers and previously trained personnel.[10] In addition, the ASQ-3 has been found to be accurate in identifying possible delays in development, because, in contrast with other tests, it targets observable abilities through structured and concrete questions.[11] The ASQ-3 is an instrument that has been used in different Spanish speaking countries, evidencing favourable results with regard to reliability, validity, sensitivity and specificity.[12] For example, studies have been conducted in Argentina,[13] Colombia,[8] Ecuador,[14] Chile,[15] and Peru;[16] as well as in other countries including Brazil,[10,17] India,[18] Rwanda,[19] the United Kingdom,[20] Australia[21] and China[22] among others.

At the same time, the ASQ-3 has been used to analyse how other risk factors and alterations identified in children below 5 years of age are related to neurodevelopment. For example, studies relate neurodevelopmental outcomes with environmental and risk factors such as health, nutrition, premature birth, low birth weight, seizure disorders, and thyroid functioning.[18,19,,23] Also, studies using the ASQ-3 that relate neurodevelopmental outcomes with the social, economic and cultural backgrounds of children find that children do not achieve optimal outcomes when living in environments with multiple risk factors including poverty, malnutrition, and lack of learning opportunities.[19] Finally,[24] indicate that the ASQ-3 allows parents to help in the evaluation of their children, which makes the instrument a unique and simple measure to complete, that enhances the parents' knowledge of their child's developmental repertoire as well as the detection of risk factors in developmental domains. The ASQ-3, thus, examines the concerns parents have regarding their children's behaviour, gives early warnings with respect to development, and can lead on to more in-depth tests when indicated. The overarching goal of this study, then, was to investigate the psychometric properties of the ASQ-3 in Columbia by measuring reliability, construct validity and convergent validity, when compared to the EAD-3. Results are expected to contribute to the psychometric evidence of the ASQ-3 as a questionnaire that allows the early and accurate detection of neurodevelopment difficulties with the aim of identifying delays early on and referring children for services in order to improve developmental outcomes.

Methods

Participants

The participants are residents of the city of Tunja (Colombia), capital of the department of Boyacá, a department that ranks second in malnutrition and poverty at the national level, which are conditions shown to have an effect on the development of children in the first years of life. This situation merits knowing the situation of early childhood in this geographic area in areas such as language, fine and gross motor skills and social skills in order to improve outcomes. The sample was composed of 456 children 1-36 months of age, from the city of Tunja, Colombia, selected randomly from a group of live births during the period 2014-2018, from a database provided by the Secretariat of Social Protection of the Town Hall, and corresponds to 10% of all births. Of the participants, 50.4% were girls and 49.6% were boys. A sample of between 9 and 46 children was obtained for each of the 17 ASQ-3 intervals (i.e., 2, 4, 6, 8, 9, 10, 12, 14, 16, 18, 20, 22, 24, 27, 30, 33, and 36 months). As inclusion criteria, it was necessary that families were living in the urban area of the city of Tunja and that the children were between 1 and 36 months of age. For exclusion criteria, children with any medical or developmental disorder were excluded (i.e., typically developing children were recruited with no known diagnosis of neurologic, congenital, or metabolic disease, fetal alcohol syndrome, etc., premature birth, or medical or other disabilities). Child risk status was obtained through parent interviews, during the consent process.

Outcome measures

Ages and Stages Questionnaires Third Edition ASQ-3[9]

The ASQ-3 is composed of 21 forms, completed by the parents or caregivers to detect developmental delays in children from 1 month to 5 ½ years. Each form includes 30 development items and is focused on 5 key areas: communication, gross motor skills, fine motor skills, problem-solving and personal-social behaviour. The findings of the validity of the ASQ-3 in the United States resulted in the following values: sensitivity (i.e., children to which the ASQ indicated a deficit) ranged from 85% to 92%, which indicated a high precision in detecting children with a deficit; specificity (i.e., children to which ASQ did not identify a deficit or with typical development) ranged from 78% to 92%, indicating precision in detecting children with typical development; positive predictive values (i.e., a measurement of the probability that the children detected with a deficit have poor results in standardized tests) ranged from 32% to 64%, indicating variability in its predictive capacity. Regarding internal consistency, the test-retest comparison yielded 92% agreement, and the intra-class correlations were between 0.75 and 0.82, indicating high reliability of the ASQ-3. Only the intervals for children between 1 and 36 months were included in this study; the problem-solving scale of the ASQ-3 was not used, given that the convergent measure, the EAD-3, does not measure problem solving skills.

In previous projects, parents or caregivers have responded to a self-report question about whether their child had the skill targeted by each item. However, in this research project, the mother or father was asked to interact with the child and have the child attempt to do each ASQ-3 question representing their age interval, and the research assistant wrote down the answers. As recommended by the developers, the child received 10 points for displaying the targeted skill; 5 points if the skill was present inconsistently (emerging behaviour); or 0 points if the skill was not present. The final scores of the children were categorized according to ASQ-3 scoring protocol: at expectations (normal or typical), just below expectations (at risk), or below expectations (deficit).

The ASQ-3 was translated into Spanish by the developers and revised by a group of experts including performing a back translation in order to assure meaning of items was preserved and the translation was culturally appropriate, and accessible to the diverse dialects of Spanish.[9] This version was tested on people who speak Spanish in a variety of regions of the United States (e.g., Arizona, Texas, Washington), demonstrating a similar performance to the questionnaire in English in younger children. Additional item response theory modelling studies on the English and Spanish ASQ-3 translations found that items functioned invariantly across versions, were productive in gathering information across abilities, and revealed an adequate hierarchy of difficulty order in both translations.[25] Studies with the ASQ-3 Spanish translation were also tested in Mexico with strong internal and inter-rate reliability for preschool children.[26]

Abbreviated Development Scale – 3 (EAD-3).[27] This scale was the result of a collaborative project between the Colombian Ministry of Health and UNICEF, which took place between 1987 and 1990. In 2016, there was an updating process (EAD-3) of the behavioural indicators and the age range was extended to 7 years. The update included a mapping process of items of the four development areas with diverse scales: EAD-1; EAD-2; Battelle Developmental Inventory; Bayley Scales of Infant Development; *Evaluación de desarrollo Infantil* (Evaluation of Infant development) (EDI, by its acronym in Spanish); *Instrumento de Valoración Auditiva Comunicativa para Niños de 0 a 12 años* (Instrument of Auditory and Communicative Assessment for Children from 0 to 12 Years), among others.

The EAD-3 is a screening test that seeks to identify possible risks or suspicions of developmental delays in Spanish-speaking Colombian children; it is not a diagnostic confirmation. The scale is widely used by health professionals to monitor longitudinal development in order to have a better understanding of family and social factors in the immediate environment of child. It has four areas of evaluation: gross motor skills, fine-adaptive motor skills, hearing-language, and personal-social behaviour. Items are scored with 1 if the behaviour is met and 0 if it is not. The results of the children in each one of the areas of the scale can be classified as: development expected for their age (green region), risk of developmental problems (yellow region), and suspicion of developmental problems (red region). EAD-3 reports two types of scores: direct scores and typical scores (expressed in a T scale, M=50 and DS=10).

Study design

A cross sectional descriptive study was carried out to assess the psychometric properties. Convergent validity of ASQ-3 with the EAD-3 was measured.

Procedure

The study was approved by the Ethics Committee of the *Universidad Pedagógica y Tecnológica de Colombia*. Once families of the children had been told the objective of the study and that it was of voluntary participation, they signed an informed consent form if they chose to participate. They were contacted by phone using a database provided by the Secretariat of Social Protection of Tunja (Colombia). Both instruments, the ASQ-3 and the EAD-3, were given simultaneously between November 2017 and May 2018. The order of presentation of the two instruments was randomly counterbalanced in each age range.

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Analysis plan

The descriptive and inferential analysis was carried out with the statistical package SPSS version 22. The scores of the ASQ-3 in interaction with the age factor were compared through a one-way ANOVA analysis. Psychometric properties of 17 ASQ-3 Spanish translation were explored, including sensitivity and specificity of the instrument. The convergent validity was measured through Pearson correlations and a contingency analysis between the ASQ-3 and EAD-3. We used bilateral correlations between the average scores in each neurodevelopmental domain according to age; and descriptive analysis average value for the scales of the ASQ-3, according to age group.

Results

Prevalence of neurodevelopment deficits in children of 1 to 36 months of age

Findings indicated that the prevalence of cases of children with levels of typical neurodevelopment for their age was 77.3% (*n*=360), and that the prevalence of a deficit in one or more of the neurodevelopmental areas evaluated by the ASQ-3 was 22.7% (*n*=106). Similar results were found in Kyerematen et al.,[16] Wei et al.,[22] Schonhaut et al.[28] and Romero-Otalvaro et al.[13] Table 1 shows the distribution of the cases with a deficit according to age in the ASQ-3 and EAD-3. Moreover, looking at neurodevelopmental areas evaluated in the ASQ-3, the prevalence analysis revealed that the gross motor skill scale showed the highest deficit distribution (11.8%), followed by the fine motor skill scale (9%). See Table 2.

Table 1 Percentage distribution of the prevalence of neurodevelopmental deficits in one or more areas of development evaluated by the ASQ-3 and EAD-3

Months (age)	N	Deficit frequency and percentage	
		ASQ-3	EAD-3
2	24	1(4.2%)	5(20.8%)
4	24	2(8.3%)	12(50%)
6	22	6(27.3%)	9(40.9%)
8	27	13(48.1%)	1(3.7%)
9	13	3(23.1%)	0(0%)
10	10	10(100%)	1(10%)
12	27	10(37%)	3(11.1%)
14	29	7(24.1%)	7(24.1%)
16	19	6(31.6%)	4(21.1%)
18	23	5(21.7%)	6(26.1%)
20	24	5(20.8%)	4(16.7%)
22	26	0(0%)	1(3.8%)
24	30	6(20%)	9(30%)
27	46	13(28.3%)	29(63%)
30	41	7(17.1%)	17(41.5%)
33	38	4(10.5%)	6(15.8%)
36	43	8(4.7%)	11(25.6%)
Total	466	106(22.7%)	125(26.8%)

Source: the authors

Table 2 Percentage distribution of the prevalence of neurodevelopmental deficits

Months (age)	N	Deficit frequency and percentage			
		Gross motor skill	Fine motor skill	Communication	Personal-social
2	24	1(4.2%)	0(0%)	0(0%)	0(0%)
4	24	2 (8.3%)	1(4.2%)	0(0%)	1(4.2%)
6	22	6(27.35%)	0(0%)	0(0%)	1(4.5%)
8	27	9 (33.3%)	6(22.2%)	1(3.7%)	0(0%)
9	13	3(23.1%)	1(7.7%)	0(0%)	0(0%)
10	10	1(10%)	10(100%)	0(0%)	0(0%)
12	27	8(29.6%)	2(7.4%)	0(0%)	0(0%)
14	29	5(17.2%)	3(10.3%)	2(6.9%)	1(3.4%)
16	19	6(31.6%)	1(5.3%)	1(5.3%)	0(0%)
18	23	3(13%)	2(8.7%)	2(8.7%)	1(4.3%)
20	24	2(8.3%)	1(4.2%)	3(12.5%)	1(4.2%)
22	26	0(0%)	0(0%)	0(0%)	0(0%)
24	30	0(0%)	2(6.7%)	4(13.3%)	3(10%)
27	46	5(10.9%)	6(13%)	6(13%)	3(6.5%)
30	41	1(2.4%)	2(4.9%)	6(14.6%)	1(2.4%)
33	38	1(2.6%)	2(5.3%)	1(2.6%)	1(2.6%)
36	43	2(4.7%)	3(7%)	7(16. 3%)	4(9.3%)
Total	466	55(11.8%)	42(9%)	33(7.1%)	17(3.7%)

Source: the authors

Validity of the ASQ-3

The overall agreement of ASQ-3 domains in each interval ranged from 82% to 92%, which indicates their usefulness for detecting, with high precision, cases of boys and girls with a deficit in their neurodevelopment, as well as cases with the neurodevelopmental level as expected for their age. However, each of the evaluation scales revealed varying results regarding specificity and sensitivity. Table 3 shows the results of this diagnostic analysis of the ASQ-3 in relation to the EAD-3 test.

The analysis showed that in the ASQ-3 scores were obtained with a specificity of 89%, and sensitivity of 73% in the communication scale. The results of the gross motor and personal-social scales presented high levels of specificity (93% and 94%, respectively), but medium levels of sensitivity (40% and 47%, respectively). What this

indicates is that researchers and evaluators can identify with precision those boys and girls with their neurodevelopment as expected for their age, but there could be cases in which children with normal neurodevelopment are identified as at risk or with a deficit. Finally, for the fine motor skill scale there was high specificity (96.9%), but very low sensitivity (9.5%), which means that the scale detects with precision those children with their neurodevelopment as expected for their age, with the possibility of many cases of boys and girls with adequate levels of neurodevelopment detected as if they were individuals with a deficit or at risk.

Moreover, the analyses from the Chi square analysis revealed that each one of the neurodevelopmental scales showed that there was agreement between the EAD-3 and ASQ-3 in diagnosing difficulties and normality in the neurodevelopment of children between 1 and 36 months of age. Statistical analysis showed high agreement for the gross motor scale between the EAD-3 and the ASQ-3 ($X^2_{(1, n=466)}$=54.016, p=0.00); in the fine motor skill scale for both tests ($X^2_{(1, n=466)}$=4.534, p=0.033), in the language scale of the EAD-3 and communication scale of the ASQ-3 ($X^2_{(1, n=466)}$=92.647,p=0.00); and in the socio-individual scale of the EAD-3 and the personal-social scale of the ASQ-3 ($X^2_{(1, n=466)}$=38.188, p=0.00) Table 3.

Table 3 Descriptive analysis of positive and negative cases for each of the scales of the EAD-3 and ASQ-3

EAD	ASQ-3			Sensitivity	Specificity	Positive predictive value	Negative predictive value	Positive likelihood ratio	Negative likelihood ratio	Total power of the test
	At-risk	No-risk	Total							
Gross motor skill				40%	93%	43%	92%	0.65	0.18	86.70%
At-risk	382a	33b	415							
	92.90%	60.00%	89.10%							
No-risk	29a	22b	51							
	7.10%	40.00%	10.90%							
Total	411	55	466							
Fine motor skill				9.50%	96.90%	23.50%	91.50%	3.06	0.93	89.10%
At-risk	411a	38b	449							
	96.90%	90.50%	96.40%							
No-risk	13a	4b	17							
	3.10%	9.50%	3.60%							
Total	424	42	466							
Communication – Language				73%	89%	34.30%	97.70%	6.86	0.31	88.20%
At-risk	387a	9b	396							
	89.40%	27.30%	85.00%							
No-risk	46a	24b	70							
	10.60%	72.70%	15.00%							
Total	433	33	466							
Personal-social – Socio-individual				47%	94%	22.20%	97.90%	7.6	0.56	92%
At-risk	420a	9b	429							
	93.80%	52.90%	92.30%							
No-risk	28a	8b	36							
	6.30%	47.10%	7.70%							
Total	448	17	465							

Source: the authors. [a, b.] Each letter of the subscript denotes a sub-group of categories, the column proportions of which do not significantly differ from each other in the .05 level.

At the same time, the analysis of partial correlations between the scales of the EAD-3 and ASQ-3, analyzed by age, indicated that there are significant bilateral correlations ($p< 0.001$) between the scales of the tests: a) fine motor skill EAD-3/ASQ-3 (r=0.274**); b) gross motor skill EAD-3/ASQ-3 (r=0.325**); c) language EAD-3 and communication ASQ-3 (r=0.431**); and d) socio-individual EAD-3 and personal-social ASQ-3 (r=0.236**). The statistical analysis reveals that there are significant differences in the average scores in each of the neurodevelopmental domains according to age (Table 4).

The data collected were analysed according to the age (months) of the participants. Table 5 shows the average value for each age, with its respective standard deviation (SD). In particular, the median and the highest scores would indicate a normal or typical neurodevelopmental level. Therefore, the child would not require additional evaluation or treatment. For their part, the scores below 1.0 SD would indicate the need to monitor the neurodevelopment of the child by a specialist in the field Table 5.

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Table 4 One-way ANOVA analysis for the ASQ-3 scales in relation to age

ASQ-3 Domains	F	Sig.
Gross motor skill	11.645	0
Fine motor skill	3.569	0
Communication	6.049	0
Personal-social	2.773	0

Source: the authors. (*gl*= 16; *n*=466)

Table 5 The average value for each age for the scales of the ASQ-3, according to age group

ASQ-3 scale	Gross motor skill				Communication			Fine motor skill			Personal-social		
Months (age)	N	M	SD	1.0[a] SD	M	SD	1.0[a] SD	M	SD	1.0a SD	M	SD	1.0[a] SD
2	24	56.04	0.99	55.05	56.25	1.17	55.08	53.33	1.22	52.11	55	1.04	53.96
4	24	55.2	1.48	53.72	58.54	0.63	57.91	53.33	2.3	51.03	53.54	1.76	51.78
6	22	38.18	2.58	35.6	55.45	1.18	54.27	55.68	1.5	54.18	50.91	1.53	49.38
8	27	46.85	2.03	44.82	55.93	1.06	54.87	56.85	0.89	55.96	57.04	0.81	56.23
9	13	43.46	3.06	40.4	55.77	1.48	54.29	53.85	2.05	51.8	48.85	2.05	46.8
10	10	50	2.23	47.77	56.5	1.3	55.2	53	1.33	51.67	51.5	1.83	49.67
12	27	39.25	3.13	36.12	54.81	1.26	53.55	53.33	1.28	52.05	52.96	0.97	51.99
14	29	47.24	2.41	44.83	52.41	1.96	50.45	46.21	2.31	43.9	53.45	1.59	51.86
16	19	48.68	2.61	46.07	46.05	2.21	43.84	51.32	1.94	49.38	55.53	1.42	54.11
18	23	55.21	1.7	53.51	41.3	2.86	38.44	50.22	1.7	48.52	54.78	1.97	52.81
20	24	55.62	1.09	54.53	46.25	2.35	43.9	53.33	1.15	52.18	52.92	1.08	51.84
22	26	53.26	1.03	52.23	49.62	1.85	47.77	55.38	0.87	54.51	55	0.92	54.08
24	30	56.33	0.792	55.53	49.67	2.08	47.59	52.33	1.37	50.96	50.83	1.24	49.59
27	46	50	1.3	48.7	49.89	1.22	48.67	47.17	1.53	45.64	49.46	1.3	48.16
30	41	53.04	1.04	52	51.1	1.55	49.55	50.12	1.42	48.7	55	0.87	54.13
33	38	55.52	0.79	54.73	53.95	1.1	52.85	48.29	1.64	46.65	53.55	1.11	52.44
36	43	56.27	0.72	55.55	50.58	1.5	49.08	49.07	1.73	47.34	51.51	1.24	50.27
Total	466	51.24	0.47	50.77	51.73	0.44	51.29	51.33	0.42	50.91	53.04	0.334	52.706

Source: the authors. [a] 1.0 SD need for monitoring the child's neurodevelopment.

Discussion

The recommendations for psychometric properties of neurodevelopmental screening instruments suggests that, aside from being reliable, the results reflect a sensitivity and specificity higher than 0.70.[29] With these properties, evidence suggests the test will detect those children, who present a deficit in one or several areas of neurodevelopment and, also, avoid reporting a risk that does not actually exist. The findings of this study revealed that the levels of specificity of the test were high when comparing the ASQ-3 and EAD-3, whereas sensitivity levels were lower (except for the communication and language scales). Similar studies show that these validity indicators tend to vary in different populations. For example, some studies in North American, Indian, Brazilian and Australian ethnic groups show high levels of sensitivity and specificity.[10,30–33] However, in studies carried out by Ballantyne et al.[34] and Astivia et al.[35] on a Canadian population, the element of sensitivity was moderate for the scales of gross motor skill and personal-social, and low for the fine motor skill scale.

In this respect, it is suggested that the assessment be complemented with confirmatory diagnostic tests in order to avoid the report of false positives and that the relationship between socio-cultural characteristics and neurodevelopment be studied to identify reasons for differences in empirical validity indicators. The American Association of Pediatrics (2019), Jee et al.[36] Guevara et al.[37] and Jiménez-Martinez et al.[13] recommend that clinic evaluation be complemented with standardised screening tests at specific ages or in response to risk possible factors. Regarding convergent validity, agreement between the ASQ-3 and EAD-3 was explored. The data showed that there was significant bilateral correlation for the scales in both tests, thus, contributing empirical evidence of the usefulness of the ASQ-3 as a screening test for child neurodevelopment. The ASQ-3 has also be studied with diverse children, such as in Squires, Bricker and Potter[31] with the Battelle Developmental Inventory in the North American population; Juneja et al.[30] with the Bayley Scales of Infant Development -2nd edition (BSID-II), in the Indian population; Halbwachs et al.[38] with Wechsler Intelligence Scale for Children-third edition in the French population; Schonhaut et al.[15] with the Bayley Scales of Infant Development of Infant and Toddler Development- 3rd edition for the Chilean population; Romero-Otálvaro et al.[13] with the National Investigation Test *(Prueba Nacional de Pesquisa*).

The average scores were consistent with those reported in the ASQ-3 manual and those found by Lopes et al.[17] who did not find a need to alter cutoff scores. By contrast, varying average scores were reported with Brazilian children by Filgueiras et al.[10] and by Alvik and Grøholt[39] with a Norwegian population, where mean scores were smaller, and with the study of Hornman et al.[40] in which all the mean scores were larger than those reported by the developers. The scores of the boys and girls of this Colombian sample showed that gross motor skills and fine motor skills showed the most risk; results that agreed with previous studies carried by Demestre et al.[15] Ballantyne et al.,[34] and Aakre et al.[41] It is possible that this difference may be due to cultural differences, given that motor skills include various concepts, such as child independence[18] and social behaviours are culturally influenced.[17] In addition, it is possible to observe that when children are older, the mean scores rise, a similar tendency reported in studies by Steenis et al.[42] and Rubio-Codina et al.[8] given that they are correlated with a set of socio-economic variables (socio-economic level, educational level of the parents, and access to social security), and of the culture of the child and the mother (traditions, beliefs and customs related to the upbringing). To conclude, this study is a pioneer in Colombia in using a validated test widely used in European

countries and the United States for child development screening. In this study, we compared the ASQ-3 with a standardized screening test (EAD-3) widely used in the Colombian population. The results of this pioneering study indicate that the ASQ-3 allows accurate detection of children at risk of presenting delays in their neurodevelopment.

Limitations

This study has some limitations. First, despite using probability sampling, the number of children per age group was insufficient to examine reliability. This can restrict the representativeness of the populations and the generalizability of the results. Secondly, we used a one-time transactional measure, which restricts identifying stability or change in the neurodevelopment of children. Third, the EAD-3 lacks a problem-solving scale, which the convergent validity of the ASQ-3 scale was not found. However, it should have been found with other tests, given that this domain may be the most sensitive in the identification of autism spectrum disorders in young children, which would help in the screen and treatment of early neurodevelopmental problems.

Future studies

For future studies, we suggest using cluster or stratified sampling to obtain a representative sample from each age group. Also, we also suggest including samples from different geographic areas of the country, with conditions of socioeconomic vulnerability. This will allow collecting evidence of validity and reliability to generalize to the population. Further studies can examine the internal consistency and stability of the scores obtained using the test-retest method, the McDonald's W, or equivalent tests. Likewise, it is necessary to measure sociodemographic variables (i.e., age and educational level of the mothers) to broaden the analysis of the influence or relationship that they may have on child development. Through further studies with diverse populations, the use of the ASQ-3 for developmental screening may assist in improving outcomes for vulnerable children and their families in Columbia.[43]

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Conflicts of interest

The author declares there is no conflict of interest.

References

1. Medina-Alva M, Caro I, Muñoz P, et al. Neurodesarrollo infantil: caracteristicas normales y signos de alarma en el niño menor de cinco años. *Revista Peruana de medicina experimental y salud publica.* 2015;32(3):565–573.
2. Organización Mundial de la Salud (OMS) & Organización de las Naciones Unidas (UNICEF). *El desarrollo del niño en la primera infancia y la discapacidad Malta: OMS*. 2013. p. 1–44.
3. Walker S, Wachs D, Grantham-Mcgregor T, et al. Inequality in early childhood: Risk and protective factors for early child development. *Lancet.* 2011;378:1325–1338.
4. Asociación Americana de pediatría. *Evaluación de problemas de aprendizaje*. 2019.
5. Bernard van Leer Foundation. *Un buen inicio: avances en el desarrollo de la primera infancia*. Espacio para la infancia. 2015.
6. Grupo de Vigilancia en Salud Pública. *Informe del comportamiento de los eventos de vigilancia nutricional, Boyacá I trimestre de 2018*. Gobernación de Boyacá. 2018.
7. Fiszbein A, Guerrero G, Rojas V. Medición del desarrollo infantil en América Latina: Construyendo una agencia regional. *El diálogo liderazgo para las Américas y Grupo de análisis para el desarrollo.* 2016.
8. Rubio-Codina M, Araujo M, Attanasio O, et al. Concurrent Validity and Feasibility of Short Tests Currently Used to Measure Early Childhood Development in Large Scale Studies: Methodology and Results. *Inter-American Development Bank, Social Protection and Health Division.* 2016;1–45.
9. Squires J, Bricker D. *Ages & Stages Questionnaires, 3rd Edition*. Baltimore: Paul Brookes Publishing. 2009.
10. Filgueiras A, Pires P, Maissonette S, et al. Psychometric properties of the Brazilian-adapted version of the Ages and Stages Questionnaire in public child daycare centers. *Early Human Development*. 2013;89(8):561–576.
11. Schonhaut L, Armijo RI. Applicability of the Ages & Stages Questionnaires (ASQ) as a developmental screening tool for psychomotor delay. *Revista Chilena de Pediatría*. 2014;85(1):12–21.
12. Singh A, Yeh CJ, Blanchard SB. Ages and stages questionnaire: a global screening scale. *Boletín Médico Del Hospital Infantil de México (English Edition*). 2017;74(1):5–12.
13. Jiménez-Martínez M, Romero-Otálvaro A, Calle-Sandoval D, et al. *Aproximaciones a la Caracterización Neuropsicológica de la Primera Infancia en Colombia*. *Editorial UPTC*, *ISBN*, 978-958-660-266-2. Colección investigación No 76, 8-150. 2018.
14. Handal AJ, Lozoff B, Breilh B, et al. Effect of community of residence on neurobehavioral development in infants and young children in a flower-growing region of Ecuador. *Environ Health Perspect.* 2017;115(1):128–133.
15. Demestre X, Schonhaut L, Morillas J, et al. Development deficit risks in the late premature newborn: evaluation at 48 months using the Ages & Stages Questionnaires®. *Anales de Pediatría (English Edition)*. 2016;84(1):1–66.
16. Kyerematen V, Hamb A, Oberhelman RA, et al. Exploratory application of the Ages and Stages (ASQ) child development screening test in a low-income Peruvian shantytown population. *BMJ open*. 2014;4(1):1–3.
17. Lopes S, Graça P, Teixeira S, et al. Psychometric properties and validation of Portuguese version of Ages & Stages Questionnaires (3rd edition): 9, 18 and 30 Questionnaires. *Early Human Development*. 2015;91(9):527–533.
18. Kvestad I, Taneja S, Hysing M, et al. Diarrhea, stimulation and growth predict neurodevelopment in young North Indian Children. *PLoS ONE*. 2015;10(3).
19. Kirk CM, Uwamungu JC, Wilson K, et al. Health, nutrition, and development of children born preterm and low birth weight in rural Rwanda: a cross-sectional study. *BMC Pediatrics*. 2017;17(1):191.
20. Nan C, Piek J, Warner C, et al. Trajectories and predictors of developmental skills in healthy twins up to 24 months of age. *Infant Behavior and Development*. 2013;36(4):670–678.
21. Skellern CY, Rogers Y, O'Callaghan MJ. A parent-completed developmental questionnaire: follow up of ex-premature infants. *J Paediatr Child Health.* 2001;37(2):125–129.
22. Wei M, Bian X, Squires J, et al. Studies of the norm and psychometrical properties of the ages and stages questionnaires, with a Chinese national sample. *Zhonghua er ke za zhi Chinese journal of pediatrics*. 2015;53(12):913–918.
23. Eom S, Dezort C, Fisher B, et al. A simple behavioral-developmental checklist versus formal screening for children in an epilepsy center. *Epilepsy and Behavior*. 2015;46:84–87.

24. Kleinert L, Barth M. Involving parents in the evaluation of familial need of support in pediatrics Elternbeteiligung bei der Einschätzung des familiären Unterstützungsbedarfs in der Pädiatrie. *Pravention Und Gesundheitsforderung*. 2015;10(2):186–191.
25. Pomes M, Squires J, Yovanoff P. Psychometric examination of a Spanish translation of a developmental screening instrument. *Journal of Early Childhood Research*. 2014;14(2):132–135.
26. Ortiz-León S, Granados-Rojas A, Cavazos-Olivo J, et al. Internal and inter-rater reliability of the ASQ-3 in Mexican preschoolers, *Salud Mental*. 2018;41(2):62–72.
27. Pontificia Universidad Javeriana. Escala Abreviada de Desarrollo – 3. 2016.
28. Schonhaut L, Pérez M, Castilla AM, et al. Validez del Ages & Stages Questionnaires para predecir el desempeño cognitivo en los primeros años de educación escolar. *Revista chilena de pediatría*. 2016;88(1):28–34.
29. Romo-Pardo B, Liendo-Vallejos S, Vargas-López G, et al. Pruebas de tamizaje de neurodesarrollo global para niños menores de 5 años de edad validadas en Estados Unidos y Latinoamérica: revisión sistemática y análisis comparativo. *Boletín médico del Hospital Infantil de México*. 2012;69(6):450–462.
30. Juneja M, Mohanty M, Jain R, et al. Ages and Stages Questionnaire as a screening tool for developmental delay in Indian children. *Indian Pediatr*. 2012;49:457–461.
31. Squires J, Bricker D, Potter L. Revision of a parent-completed developmental screening tool: Ages and Stages Questionnaires. *J Pediatr Psychol*. 1997;22(3):313–28.
32. Simpson S, D'Aprano A, Tayler C, et al. Validation of a culturally adapted developmental screening tool for Australian Aboriginal children: Early findings and next steps. *Early human development*. 2016;103:91–95.
33. Vameghi R, Sajedi F, Kraskian-Mojembari A, et al. Cross-Cultural Adaptation, Validation and Standardization of Ages and Stages Questionnaire (ASQ) in Iranian Children. *Iran j Publ heal.* 2013;42(5):522–528.
34. Ballantyne M, Benzies KM, McDonald S, et al. Risk of developmental delay: Comparison of late preterm and full term Canadian infants at age 12 months. *Early human development*. 2016;101:27–32.
35. Astivia OLO, Forer B, Dueker GL, et al. The Ages and Stages Questionnaire: Latent factor structure and growth of latent mean scores over time. *Early human development*. 2017;115:99–109.
36. Jee SH, Szilagyi M, Ovenshire C, et al. Improved detection of developmental delays among young children in foster care. *Pediatrics*. 2010;125(2):282–289.
37. Guevara JP, Gerdes M, Localio R, et al. Effectiveness of developmental screening in an urban setting. *Pediatrics*. 2013;131(1):30–37.
38. Halbwachs M, Muller JB, Nguyen S, et al. Usefulness of parent-completed ASQ for neurodevelopmental screening of preterm children at five years of age. *Plos one.* 2013;8(8):e71925.
39. Alvik A, Grøholt B. Examination of the cut-off scores determined by the Ages and Stages Questionnaire in a population-based sample of 6 month-old Norwegian infants. *BMC pediatrics*. 2011;11(117):1–7.
40. Hornman J, Kerstjens JM, de Winter AF, et al. Validity and internal consistency of the Ages and Stages Questionnaire 60-month version and the effect of three scoring methods. *Early Human Development.* 2013;89(12):1011–1015.
41. Aakre I, Strand TA, Moubarek K, et al. Associations between thyroid dysfunction and developmental status in children with excessive iodine status. *PLOS ONE*. 2017;12(11):1–15.
42. Steenis LJ, Verhoeven M, Hessen DJ, et al. Parental and professional assessment of early child development: the ASQ-3 and the Bayley-III--NL. *Early human development*. 2015;91(3):217–225.
43. Romo -Otalvaro AMR, Grañana N, Gaeto N, et al. ASQ-3: Validation of the Ages and Stages Questionnaire for the detection of neurodevelopmental disorders in Argentine children. *Arch Argent Pediatr*. 2018;116(1):7–13.

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