

Assessment tools for evaluating neuropsychomotor development in children with visual impairment: an integrative review

Ferramentas de avaliação do desenvolvimento neuropsicomotor em crianças com deficiência visual: uma revisão integrativa

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ABSTRACT

This study, an integrative literature review, aims to find tools used in Brazil to evaluate the neuropsychomotor development of children with visual impairment. The search for articles was carried out in the Virtual Health Library, PubMed®, Scientific Electronic Library Online databases. 1552 articles were found, and after analysis, 4 studies were selected for this work. No instrument was intended to assess neuropsychomotor development as a whole for this audience. There is a need to consider other aspects of neuropsychomotor development in assessments so that this piece of information can be added to the assessment of functional vision and allow more assertive interventions, also considering multiple disabilities and cerebral visual impairment.

RESUMO

Este estudo, de revisão integrativa da literatura, tem como objetivo encontrar instrumentos validados utilizados no Brasil para avaliar o desenvolvimento neuropsicomotor de crianças com deficiência visual. A busca dos artigos foi realizada nas bases de dados Biblioteca Virtual em Saúde, PubMed® e SciELO. Foram encontrados 1.552 artigos e, após análise, foram selecionados quatro para este trabalho. Nenhum instrumento se propôs a avaliar o desenvolvimento neuropsicomotor como um todo para esse público. Há necessidade de considerar diversos aspectos do desenvolvimento neuropsicomotor para que essas informações possam ser agregadas à avaliação da visão funcional e permitir intervenções mais assertivas, considerando também deficiências múltiplas e deficiência visual cerebral.

INTRODUCTION

Visual impairment (VI) is characterized by the impairment of the visual system, causing damage to vision functions.⁽¹⁾ According to the 2022 International Classification of Diseases 11 (ICD-11), there is a division of categories: mild, moderate, and severe visual loss; blindness; near VIs. It is estimated that 2.2 million people worldwide have some kind of VI, and among at least 1 million cases, this condition could have been prevented or treated.⁽²⁾ Also according to the World Health Organization (WHO), the impact of VI on each individual's life is variable, manifesting itself according to contextual factors.

In order to mitigate the consequences of VI on child development and quality of life, early diagnosis, referrals for necessary interventions and multidisciplinary knowledge about visual changes are essential.⁽³⁾ There is also a need to expand the production of theoretical knowledge on visual health, together with subsidies for assessment, intervention, and promotion of public policies in the area.⁽⁴⁾ Finally, there are still barriers regarding information and education for parents and carers of children. There are relationships between parental misinformation and the gap between suspicion, diagnosis, and access to intervention services and ophthalmological care.⁽⁵⁾

Neuropsychomotor development (NPMD) is characterized by motor, perceptual, and psychosocial acquisitions, in a process that begins in intrauterine life and is influenced by biological factors and is sensitive to contextual factors.⁽⁶⁾ Children with VI are susceptible to developing cognitive, motor, social, emotional, and language delays.⁽⁷⁾

Cognitive development is the process by which an individual develops the ability to understand, make decisions, and solve problems. It refers to a set of mental processes such as perception, attention, memory, reasoning and imagination.⁽⁸⁾ The cognitive processes of children with VI are different from those of children without VI and occur more slowly due to limited visual stimuli.⁽⁹⁾ Therefore, the impact on cognition can be listed by mental processes that require visual information for their construction, such as the theory of mind development,⁽¹⁰⁾ and spatial cognition.⁽¹¹⁾

Motor development evolves sequentially and gradually. Consequently, the achievement of a stage requires the acquisition of the previous stage. Acquisition inversion may occur; however, general development is established hierarchically. Development begins with reflexes that disappear and are replaced by voluntary and more complex movements.⁽⁸⁾

A child with VI has the same ability to reach motor development milestones as a child without VI. Some justifications for the delay in motor gains by children with a VI are low perception of their own body, knowledge and spatial organization, low imitative motor behavior and control of the motor scheme.⁽⁹⁾ It is also known that children with VI can demonstrate passivity, having low initiative for motor actions due to limited environmental stimuli.⁽¹²⁾

Social communication and emotional development are interconnected since social and emotional exchanges are supported by the use of language.⁽⁸⁾ The same way as motor development, language development is physiologically the same in children with VI and children without VI, as the ability to make sounds is innate. Hence, what may predispose a delay are contextual factors. Among them, we can highlight the interactions and bonds of children with VI right at birth. The environment, frequency, and quality of parental interactions such as cuddling, parental narration, and involvement in activities will outline aspects of that child's development.⁽⁹⁾ Furthermore, other factors may be relevant to socio-communicative aspects, since the development of such skills is based on primarily visual stimuli, namely: observation, understanding, imitation and processing of human stimuli such as shared attention, reciprocity, body movement, postures, gestures, facial expressions, and mouth movements.⁽¹³⁾

Due to the impact that total or partial visual limitations have on the development and learning process of children, it is necessary for this public to have access to intervention services, in order to avoid or reduce losses in functionality, social participation, and activities of daily living.⁽¹⁴⁾

As a priority in clinical practice, there is the use of health assessment instruments, such as questionnaires and checklists. These instruments aim to identify alterations precisely, favoring the development of the therapeutic plan; measure clinical potentials and outcomes; monitor the therapeutic process; standardize the conduct to be used in different situations; provide epidemiological data and organize the sizing of a team.⁽¹⁵⁾

It is important to call attention to the gaps in the assessments of children with VI and highlight the need for assessments that address their behaviors, learning, occupational performance, and functionality in their lives. There are few instruments to assess children with VI, especially in Portuguese.⁽¹⁶⁾ The literature points to assessments of functional vision and quality of life. The *Avaliação da Visão Funcional* (AVIF) Test assesses the visual capacity of children with low vision aged from 2 to 6

years and, according to the manual, is aimed at vision habilitation considering child development.⁽³⁾ The *Avaliação da Visão Funcional Infantil (AVFI)* covers the functional vision of children aged from zero to 18 months.⁽¹⁷⁾

There is a demand for specific assessments for other aspects, such as delays in VI children's NPMD, participation, and activities of daily living. Assessments in eye health practices that measure visual functions, functional vision, and occupational performance are essential. Functional vision⁽¹⁸⁾ is understood as the way a person performs activities related to vision, which says a lot about a child's daily activities.

In view of the above, the use of assessment instruments with outcomes focused on NPMD of children with VI is essential for planning interventions not only for Occupational Therapy but also for the multidisciplinary team. This population tends to present delays in NPMD, even if only temporarily, which makes it important to assess their development considering their specificities. Therefore, this literature review aims to search for and analyze NPMD assessment instruments available in Portuguese, specific to children with VI.

METHODS

This is a literature review study on instruments that assess the development of children with VI. The guiding question for the aforementioned analysis was: Are there validated tests in the main open access databases in the health sector that cover VI and the assessment of NPMD in children up to seven years of age?

The search for research articles was carried out in the following databases: Virtual Health Library (VHL), PubMed®, Scientific Electronic Library Online (SciELO), with the descriptors: "visual impairment", "low vision", "blindness", "instrument", "tool", "checklist", "assessment", "scale", "development" and "neuropsychomotor development", as described in table 1.

Original articles in Portuguese were considered on validated instruments, which assess the NPMD of children with VI up to 7 years old met the inclusion criteria.

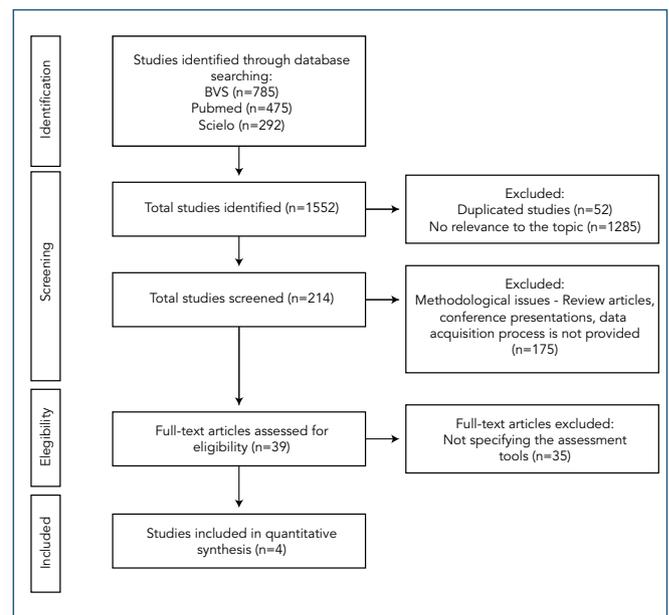
Duplicate articles, those that brought non-validated instruments, those with the objective of qualifying intervention, instruments that predict the profile of children with VI, instruments aimed at outcomes other than the assessment of NPMD, those that include a range over 7 years of age and assessments of functionality and/or visual function were excluded.

In the first search, in all databases, 1,552 articles were found. Among these, 1,286 were excluded because the title

Table 1. Databases used, terms used and number of results

Databases	Terms	Documents found (n)
SciELO	Visual impairment OR Blindness AND Instrument OR Tool OR Checklist; Blindness AND Instruments; Low Vision OR Blindness AND Development OR Neuropsychomotor Development; Visual impairment AND Instruments; Low Vision AND Instruments; Low Vision OR Visual Impairment OR Blindness AND Assessment; Visual Impairment AND Assessment; Visual impairment AND Scales	292
Virtual Health Library	Visual impairment OR Blindness AND Instrument OR Tool OR Checklist; Low Vision OR Blindness AND Development OR Neuropsychomotor Development; Blindness AND Instruments; Visual Impairment AND Instruments; Low Vision AND Instruments; Visual impairment AND Assessment; Visual impairment AND Scales	785
PubMed®	Visual impairment OR Blindness AND Instrument OR Tool OR Checklist; Low Vision OR Blindness AND Development OR Neuropsychomotor Development; Visual impairment AND Instruments; Blindness AND Instruments; Low Vision AND Instruments; Visual impairment AND Assessment; Visual impairment AND Scales	475

did not indicate terms or themes related to the inclusion criteria. There were 266 articles left to read the abstract, of which 52 were excluded due to duplication, 175 because they met the methodological exclusion criteria, such as instruments aimed at different outcomes of development assessment, age group over 7 years old or for assessing visual functionality; 39 remained and, after reading them in full, 35 were excluded for not specifying the assessment instruments so that they could be applicable to the criteria. In the end, a total of 4 articles were selected, as shown in figure 1.



VHL: Virtual Health Library; SciELO: Scientific Electronic Library Online

Figure 1. Studies selection

RESULTS

In this research, 4 articles were used out of the 39 read in full. All studies belong to Brazilian literature. Among

Table 2. List of selected articles

Article	Type of study	Instruments used	Publication, year	Objective	Participants
Santos et al. ⁽¹⁹⁾	Methodological study of instrument adaptation	EDM	Rev Bras Ed Esp 2020	To contribute to the area of assessment of motor performance in VI children through the adaptation of the EDM	- Adaptation process: 3 children with low vision with an average age of 105.7 months - Reliability process of the adaptations: 19 children with low vision and an average age of 110.8 months
Campos et al. ⁽²¹⁾	Exploratory study	Intelligence Assessment Scale for Children with Visual Impairment	Psicologia Ciência e Profissão, 2014.	To build subtests to assess cognitive abilities of VI children; Pilot study with the purpose of verifying the adequacy of the subtests	Acquired VI - Blindness: 4 children, 2 with acquired blindness and 2 with congenital blindness
Psychometric characteristics of the "Portable Tactual Performance Test" (P-TPT) in blind individuals ^(22,23)	Methodological study	P-TPT	Ciência & Cognição, 2012.	To evaluate psychometric characteristics of the P-TPT	32 children with congenital visual impairment, average age of 9.97 years
Cunha et al. ⁽²⁴⁾	Methodological study	PBFG-DV CATAM EMMC	Paidéia, 2011.	To expand the use of assisted testing in children with VI. To verify the applicability of CATAM for children with visual impairment	12 children with moderate low vision, aged between 5 years and 2 months to 9 years

EDM: Escala de Desenvolvimento Motor; P-TPT: Portable Tactual Performance Test; PBFG-DV: Perguntas de Busca com Figuras Geométricas para Crianças com Deficiência Visual; CATAM: Children's Analogical Thinking Modifiability; EMMC: Escala de Maturidade Mental Columbia.

them, the most recent one was published in 2020, and the others were published in 2014, 2012 and 2011, respectively. All of the articles have more than one author, among them professionals from the following areas could be found: physiotherapy, in 25% of the studies, and psychology, in 75% of them.

In the studies on the use of instruments with children with VI, a total of 6 tools were exposed. There are five cognitive skills tests and one motor skill test. Among these, five are already existing instruments, originating from previous studies. However, one out of the six instruments was developed especially for the target audience. Regarding the samples, one study includes low vision and blindness, two include only low vision and one includes only blindness. Besides, only half of the samples specify the type of disability, acquired or congenital. The ages assessed range from 5 years and 3 months to 12 years. The summary of the characteristics of the selected articles is shown in table 2, describing the year and magazine; the kind of study; goal; instruments used and participants.

The characteristics of the instruments used in this research, according to what was described and proposed in the selected articles, are shown in table 3. It includes information about the particularities necessary to carry out each test, the skills assessed, the functions required for execution of the test, information about the public to be examined, type of VI, degree, scope in cases of comorbidity, age and, finally, information about applicators, mentioning categories of professionals who can apply the instruments.

The adaptation of the *Escala de Desenvolvimento Motor* (EDM)⁽¹⁹⁾ for children with VI showed good methodological

reliability, allowing for the correct application of the original scale proposed for children with low vision.⁽²⁰⁾

The Intelligence Assessment Scale for Children with Visual Impairment⁽²¹⁾ is an instrument created to assess the intelligence of VI children aged 7 to 12 years. It is important to highlight that this instrument proposal presented by the authors still requires adjustments and reformulations.

The Portable Tactual Performance Test (P-TPT) is a subtest that was adapted for children with VI.^(22,23) The study selected for this research describes the psychometric characteristics of the adapted version in Brazilian children with congenital blindness. It is worth noting that the study for this research is not characterized as a validation or standardization study of the test as the quantity and quality of the sample are limited, yet P-TPT shows good capacity for assessing cognitive aspects and can be used as a tool by Brazilian professionals.

The question game of search with geometric figures for children with VI, *Perguntas de Busca com Figuras Geométricas para Crianças com Deficiência Visual* (PBFG-DV),⁽²⁴⁾ uses a small sample and data from the application of assisted and psychometric tests, proving to be suitable for cognitive assessment of children with VI aged 5 years and 2 months to 9 years. It uses three instruments: PBFG-DV, an adapted assisted test⁽²⁵⁾ and the *Escala de Maturidade Mental Columbia* (EMMC).⁽²⁶⁾ The EMMC is favorable for measuring cognitive performance. Children's Analogical Thinking Modifiability Test (CATM)⁽²⁷⁾ was the one which gave rise to adapted versions⁽²⁵⁾.

These last two instruments were not designed for children with VI, which makes it essential that subsequent studies verify their suitability for the population with VI.

Table 3. Instrument list

Instrument	Assessed skills	Adaptation to application and/or material	Required functions	VI specificities	Age	Professional s
EDM	Motor development: global motor skills, fine motor skills. spatial awareness, body structure, balance and lateralization	Material adaptation: use of color contrasts (black, white, yellow, use of texture; materials commonly used in everyday life (6B pencil); lighting (60W lamp) Environmental adaptation: marked trail Adaptation in instruction: the examiner performs the task very close to the child Preparatory exercise: feeling the object beforehand; feeling the movement of the evaluator	Visual functions; tactile and kinesthetic functions; auditory functions	Degree: low vision Type: not informed Comorbidities: Not applicable in cases of comorbidities (hearing impairment, orthopedic alterations, behavioral problems, neurological disorders)	7 to 10 years old	Multidisciplin ary
Intelligence Assessment Scale for Children with Visual Impairment Portable Tactual Performance Test	Cognitive skill memory, verbal intelligence, logical-spatial reasoning Cognitive development, psychomotor development, spatial location, spatial memory, sensory motor skills, hepatic perception, interconnection of the cerebral hemispheres	Materials: textured pieces and rubberized sheet for figures Tasks: oral and manual Task adaptation: replacing the task of drawing the figures by organizing them on a sheet of paper, with the examiner having to trace the contours of the figures with a pencil	Visual, auditory and tactile functions Tactile functions	Degree: low vision; blindness Type: congenital; acquired Comorbidities: not specified Degree: blindness Type: congenital Comorbidities: not specified	7 to 12 years old 7 to 12	Not informed Not informed
PBFG-DV	Cognitive skills: problem solving	Material adaptation: paper boards and rubberized material Preparatory exercise: previous presentation of model cards	Tactile functions	Degree: moderate low vision Type: not specified Comorbidities: not specified	5 years and 2 months to 9 years old	Not informed
CATAM	Cognitive skills: logical reasoning	Material: wooden blocks and pieces of different sizes, colors and shapes Preparatory exercise: preview presentation of the blocks	Tactile functions	Degree: moderate low vision Type: not specified Comorbidities: not specified	5 years and 2 months to 9 years old	Not specified
EMMC	Cognitive skills: general reasoning	Adaptation material: boards with figures in dimensions according to the visual conditions of the children in the study	Tactile functions	Degree: moderate low vision Type: not specified Comorbidities: not specified	5 years and 2 months to 9 years old	Not specified
Psychometric and assisted cognitive assessment of children with moderate low vision	Methodological study	PBFG-DV CATAM EMMC	Tactile functions	To expand the use of assisted testing in children with VI. To verify the applicability of CATAM for children with VI	2 children with moderate low vision, aged between 5 years and 2 months to 9 years old	Methodological study

EDM: Escala de Desenvolvimento Motor; PBFG-DV: Perguntas de Busca com Figuras Geométricas para Crianças com Deficiência Visual; CATAM: Children's Analogical Thinking Modifiability; EMMC: Escala de Maturidade Mental Columbia.

DISCUSSION

As far the results are concerned, a discrepancy can be seen in the different developmental functions to be assessed in the instruments found, among which no instrument assesses NPMD as a whole. One instrument specifically assesses motor conditions, four specifically assess cognitive skills and none specifically assesses social, emotional and/or communicative skills.

It is important to highlight that VI in childhood can lead to significant gaps in socio-emotional and communicative skills. For this reason, children with VI are likely to have implications for the quality of family interaction and lower emotional regulation.⁽²⁸⁾

On the other hand, the existence of a specific test to assess the motor development of children with VI can be justified by the incidence of impairment of skills such as mobility⁽²⁹⁾ and others of this health condition, as well as by the functional impact associated with such impairments. It is known that the motor aspect is a set of skills necessary to carry out and organize daily activities, enabling autonomy and independence,⁽³⁰⁾

which influences playing, participation, self-care, and mobility.

This functionality relationship can be applied when we analyze the majority of instruments for assessing cognitive abilities and intelligence, as cognition is widely required in everyday activities, especially in academic activities.⁽³⁰⁾ Assessment instruments can be allies in inclusive education, since, for the use of strategies that aim to minimize existing gaps, such as the *Plano Educacional Individualizado* (PEI), information on the student's level of development and specific abilities are needed.⁽³¹⁾ It can, therefore, be inferred that the result of a greater number of instruments that assess cognitive aspects of children with VI, found in this research, may be related to the fact that cognitive processes are the target of health actions as well as education actions, thus providing further research on the topic.

Taking into consideration that a child with VI has limitations in the most sophisticated route of information acquisition, the studies selected in this research make use of adaptations and resources that use other information

routes to applicability of the instruments to the target audience. The studies use and organize information by recruiting auditory, tactile and kinesthetic functions. Touch predicts information about object characteristics, texture, temperature, and size; the kinesthetic informs about movement, position, wind direction, spatial orientation, and speed.⁽³²⁾ The auditory system assumes spatial analysis⁽³³⁾ and is a receiver of information and concepts through speech.⁽³²⁾ The studies also included the adaptation and use of improvement aids for carrying out the tests. All articles selected in this research, despite their specificities and differences, converge on one point: investigation of assessment instruments with children with VI. However, it is necessary to pay attention to the scope and specificity of this health condition. Based on this assumption, in order to understand the samples and clinical applicability of the findings in the selected studies, it is essential to take into account some dimensions of VI such as etiology, type, and degree.

The ICD-11 does not use the term low vision.⁽⁴⁾ However, as the analyzed articles use the term low vision, we will use another reference for the terminology. According to the International Council of Ophthalmology (2002),⁽³⁴⁾ low vision can be considered as visual loss at lower levels, in which the individual presents better visual resolution through resources.

It is also notable that 50% of the samples were characterized according to the type of disability: congenital and acquired. This fact interferes with the applicability of the instruments since children with congenital visual limitations tend to acquire more robust compensatory abilities,⁽³²⁾ and children who lose their vision seem to have more difficulty adapting emotionally to their sensory condition and also interpreting the information around them through other sensory channels.⁽³⁵⁾

Only one out of the five articles explains the relationship between the instrument and the population with VI with other associated conditions, in which the instrument in focus is not applicable in cases of comorbidities. The other studies do not mention possible applicability in these cases. Multiple disabilities and comorbidities can present particular manifestations in children, as in addition to the sensory impact, specific cognitive, behavioral and physical impairments can be found, significantly interfering with learning, motivation and engagement.⁽³⁶⁾ The association of more than one health condition can also occur in cerebral visual impairment (CVI). The articles retrieved by this research do not explain the use of their tests in cases of CVI.

The number of instruments aimed at school-age children was considerably greater when compared to the number of those aimed at preschool-age children. Studies report that the earlier children with VI undergo intervention programs, the better their development, participation, and quality of life will be.⁽³⁷⁾ Considering the fact that health interventions use assessment instruments to support their practice,⁽³⁸⁾ the low number of tools for preschoolers found in this research may illustrate a gap between what is indicated in the literature and what is as input for health actions in Brazil.

Studies indicate that the domain of knowledge, involvement, and actions in health at a multidisciplinary level is considered an ideal scenario for robustness in the area of eye health.⁽⁴⁾ However, the percentage of tests with description and information about the application and multi-professional use is lower when compared to tests that do not describe and inform about the possibility of multi-professional use. Another point to be considered is the authorship of the articles used in this research, which include only two categories of professionals in studies of instruments aimed at the NPMD of the VI population. Considering the role of Occupational Therapy in this area,⁽³⁹⁾ it is worth highlighting the need for involvement of Occupational Therapy and other areas of health in order to promote the production and adaptation of tools for this public, as well as linking instruments that can be applied in a multidisciplinary way.

Furthermore, there is a lack of assessment instruments that take into account the particularities of VI, especially those aimed at NPMD as a whole. The scarce number of instruments can be explained by the heterogeneity of VI and sensory restriction of different etiologies, levels and degrees, as they present different clinical manifestations. This fact can be aggravated by the rigorous parameters necessary for the construction and adaptation of an assessment instrument, such as generalization, not changing the objective and conditions for application.⁽⁴⁰⁾

AUTHORS' CONTRIBUTION

All authors participated in the study and reviewed the submitted manuscript. Brandão, AO, and Magalhães, RC contributed to the conception and design of the study, data acquisition, as well as data analysis and interpretation. Rocha, ALL, and Costa, NO were responsible for data acquisition and analysis. Fernandes, LC, and Vasconcelos, GC conducted critical reviews of the article, contributing significantly to intellectual content.

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