

Assessment of the neuropsychomotor development of HIV-exposed infants using the ICF model

Avaliação do desenvolvimento neuropsicomotor de lactentes expostos ao HIV a partir do modelo da CIF

Evaluación del desarrollo neuropsicomotor de los lactantes expuestos al VIH con base en el modelo de CIF

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ABSTRACT | This study aimed to systematize and build a checklist with tools to assess child development according to the biopsychosocial model of the International Classification of Functioning, Disability, and Health (ICF) of infants exposed to HIV, aged from 4 to 12 months. This is an observational, analytical, and longitudinal study. Bayley-III Scale of Infant and Toddler Development; Affordances in the Home Environment for Motor Development-Infant Scale; Brazilian Criteria of Economic Classification; and infant's history used in the assessment were described according to the ICF domain categories. The tools used in this study include the components of body structure and functions; activities and participation; environmental and personal factors. The description of the assessment tools in the child development of infants exposed to HIV—by the constructs and domains of the ICF—allowed for the construction of clinical reasoning during the assessment, emphasizing the surveillance of child development and functioning in their first year of life.

Keywords | Child Development; HIV; Vertical Infectious Disease Transmission; International Classification of Functioning, Disability and Health.

RESUMO | Este estudo objetivou sistematizar e construir um checklist com instrumentos de avaliação do desenvolvimento infantil de acordo com o modelo biopsicossocial da Classificação Internacional de Funcionalidade, Incapacidade e Saúde (CIF) de lactentes nas idades entre 4 e 12 meses expostos ao HIV. Trata-se de um estudo observacional, analítico e longitudinal. Foram utilizados na avaliação

e descritos de acordo com as categorias dos domínios da CIF a escala Bayley de desenvolvimento infantil III; o questionário *Affordances* no Ambiente Domiciliar para o Desenvolvimento Motor – Escala Bebê; o critério de classificação econômica Brasil; e a ficha de avaliação com histórico do lactente. Os instrumentos trabalhados neste estudo contemplam os componentes de estrutura e funções corporais; atividades e participação; e fatores ambientais e pessoais. A descrição dos instrumentos de avaliação do desenvolvimento infantil de lactentes expostos ao HIV, por meio dos constructos e domínios da CIF, permitiu construir um raciocínio clínico durante a avaliação, enfatizando a vigilância do desenvolvimento infantil e a funcionalidade no primeiro ano de vida.

Descritores | Desenvolvimento Infantil; HIV; Transmissão Vertical de Doença Infecciosa; Classificação Internacional de Funcionalidade, Incapacidade e Saúde.

RESUMEN | Este estudio tuvo por objetivo sistematizar y construir una lista de verificación con los instrumentos para evaluar el desarrollo infantil desde el modelo biopsicosocial de la Clasificación Internacional del Funcionamiento, de la Discapacidad y de la Salud (CIF) para los lactantes de 4 a 12 meses de edad expuestos al VIH. Se trata de un estudio observacional, analítico y longitudinal. En la evaluación y siguiendo la descripción de los criterios de la CIF se utilizaron la Escala de Desarrollo Infantil de Bayley III, el cuestionario *Affordances* en el Ambiente Domiciliario para el Desarrollo Motriz –la Escala Bebé–, el criterio de clasificación económica de Brasil y el formulario de

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evaluación con la historia del lactante. Los instrumentos que se aplicaron en este estudio incluyen los componentes de estructura y funciones corporales; actividades y participación; y factores ambientales y personales. La descripción de los instrumentos para evaluar el desarrollo infantil de los lactantes expuestos al VIH por medio de los constructos y criterios de la CIF ayudó

en el razonamiento clínico durante la evaluación al enfatizar el seguimiento del desarrollo y la funcionalidad infantil en el primer año de vida.

Palabras clave | Desarrollo Infantil; VIH; Transmisión Vertical de Enfermedad Infecciosa; Clasificación Internacional del Funcionamiento, de la Discapacidad y de la Salud.

INTRODUCTION

The International Classification of Functioning, Disability, and Health (ICF) allows for a broad and holistic view of the individual's health status, besides being a reference for the multidisciplinary and/or interdisciplinary team. Above all, it proposes a model of functioning that includes the domains: body structure and functions, activities, participation, and contextual factors, which include personal and environmental factors¹. Thus, it is necessary to incorporate the research and assessment tools of at-risk infants, such as those exposed to the human immunodeficiency virus (HIV), into this model.

According to the 2020 ICF model¹, history, lifestyle, and characteristics of the individual that do not form a health condition or state are considered personal factors¹. These factors include gender, race, age, other health states, physical condition, lifestyle, habits, creation, coping methods and character, individual psychological qualities, among others, that affect disability at any level. However, personal factors are not classified in the ICF¹. Environmental factors are classified by the physical, social, and attitudinal domains, and can influence infants positively — as facilitators — or negatively — as barriers — affecting the functioning or disability during child development^{1,2}. In turn, biological (pre, peri, or postnatal) and environmental risk factors (low socioeconomic status, unfavorable physical environment, social vulnerability, violence, parents' low schooling level, and lack of access to health and schooling) may affect the course of neuropsychomotor development^{1,3,4}, causing delays⁵.

In this scenario, infants exposed to the HIV virus and antiretroviral therapy (ART) are at an increased risk of developing neuropsychomotor alterations related to the body structure and function domains⁶. Estimates show that the detection rate of pregnant women living with HIV increased by 30.3% in 10 years, which can be justified by the increase of prenatal diagnosis of the disease and

surveillance in preventing vertical transmission (VT)⁷. Thus, monitoring infants exposed to HIV in order to observe possible delays in neuropsychomotor development is necessary to minimize or to intervene early^{8,9}.

The ICF proposes to unify and standardize language for the description of health and states related to it, as well as activity, participation, and environmental and personal contexts^{10,11} of the pediatric population in situation of biological risk. Thus, the ICF can act as an understanding tool to assess infants exposed to HIV to detect it and intervene early.

This study aimed to describe the tools for assessing the development of infants exposed to HIV and apply the categories of the ICF domains in this evaluation during their first year of life.

METHODOLOGY

This observational, analytical, and longitudinal study considered the infant as a personal factor, whereas the family as part of the context in which the infant is inserted. Infants aged 4, 8, and 12 months enrolled in the Specialized Child Care Services (SAE/Infantil) of Santos (SP) were included in the study, whose parents or guardians consented to participate. Premature infants (<37 gestational weeks), those with genetic syndromes, those with neurological alterations in the central nervous system, or those whose guardians did not agree to participate in the study were excluded.

Development was evaluated by the Bayley Scales of Infant and Toddler Development III (Bayley III), which identifies, evaluates, and measures child development from 16 days to 42 months, analyzing the following development domains: cognitive domain (91 items), expressive and receptive language (48 and 19 items, respectively), gross and fine motor (72 and 66 items, respectively), adaptive and socioemotional behavior. This study evaluated the cognitive, receptive and expressive language, and gross and fine motor domains¹².

To assess the opportunities received in the home environment, the Affordances in the Home Environment for Motor Development - Infant Scale (AHEMD-IS) questionnaire was used. The quality and quantity of opportunities (resources) in the home environment of infants aged 3–18 months were evaluated based on the parents' reports¹³, by 35 items categorized into four dimensions: physical space, stimulation variety, gross and fine motor toys¹³.

The Brazilian Criteria of Economic Classification (CCEB) of the Brazilian Association of Research Companies (ABEP) was used to characterize families economically¹⁴.

The authors created an assessment form of the infant's history to verify personal data and data on the

gestational history and childbirth, care in the puerperal and post-puerperal periods. Moreover, the Booklet of Infant's Health (*Caderneta da Criança*) was used to obtain information regarding their health.

Data analysis

A checklist with the ICF categories was created according to the evaluation of child development performed. The tools were classified according to the ICF model, relating them to structures and/or functions in activities and participation, environmental, and personal factors (Figure 1).

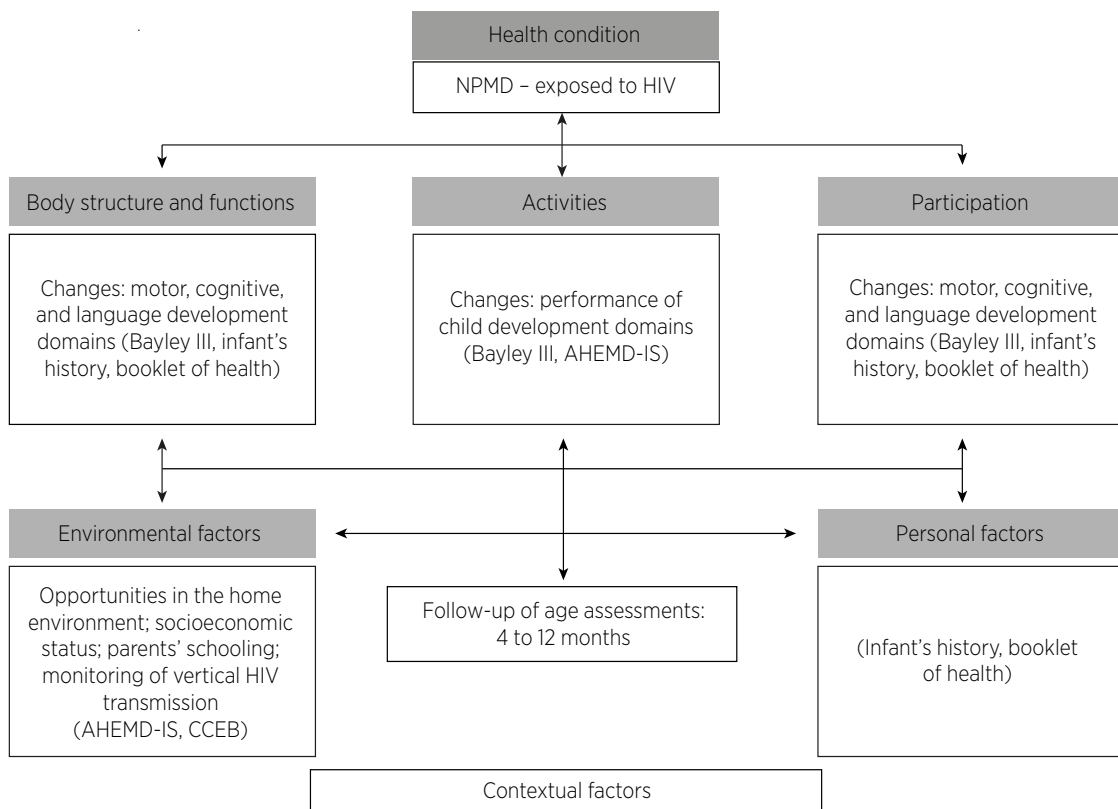


Figure 1. Assessment tools for child development by the biopsychosocial model of the International Classification of Functioning, Disability, and Health

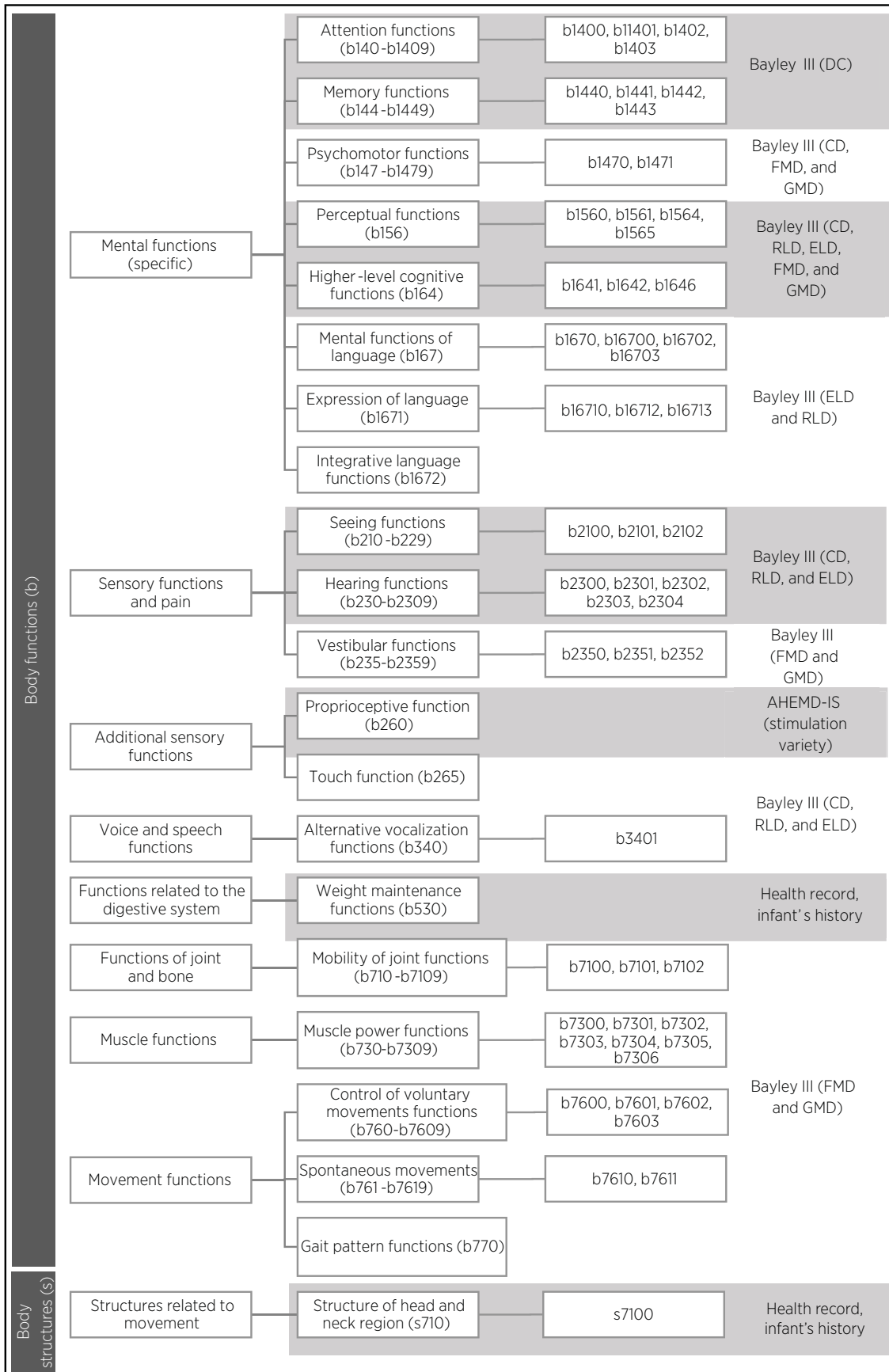
CCEB: Brazilian Criteria of Economic Classification; AHEMD-IS: Affordances in the Home Environment for Motor Development - Infant Scale; Bayley III: Bayley Scale of Infant and Toddler Development III; NPMD: neuropsychomotor development.

RESULTS

The study included 13 infants (4–12 months of age) exposed to HIV. The results were presented using the CIF codes. Numbers followed by letters refer to the chapter of the classified component, inserted to specify the magnitude of functioning or disability in that category¹. For the components of body functions and structure (Chart 1), since they are not related to the

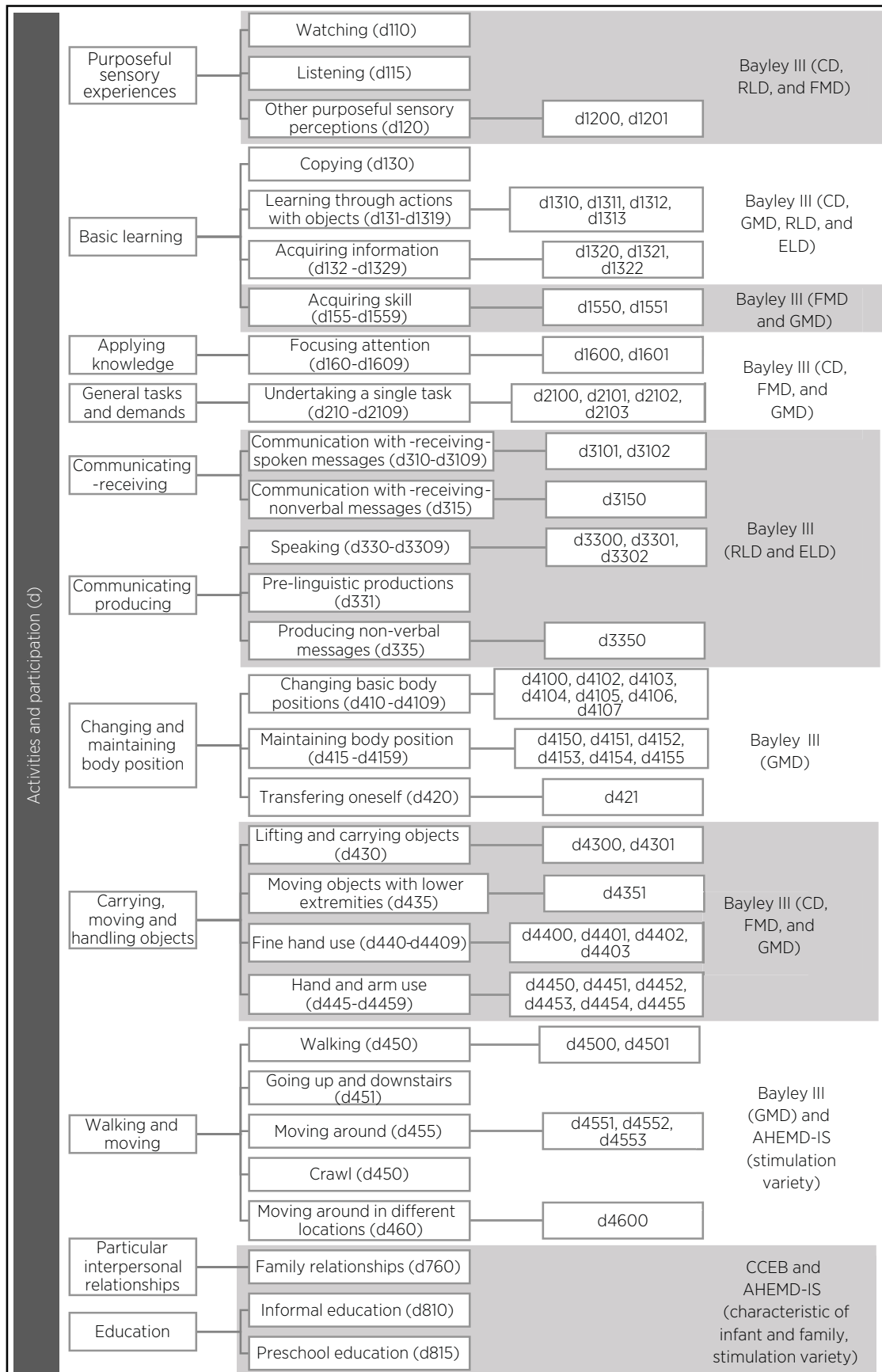
used tools, the following categories were not considered: b1562 and b1563 (perceptual functions); b1640, b164, b1645 (higher-level cognitive functions); b16701 and b16711 (mental functions of language); and b3400 (alternative vocalization functions). The relation of the checklist with the activity and participation component (Chart 2) and contextual factors, which include environmental factors and personal factors is also present (Chart 3).

Chart 1. Assessment tools that address body functions and structure



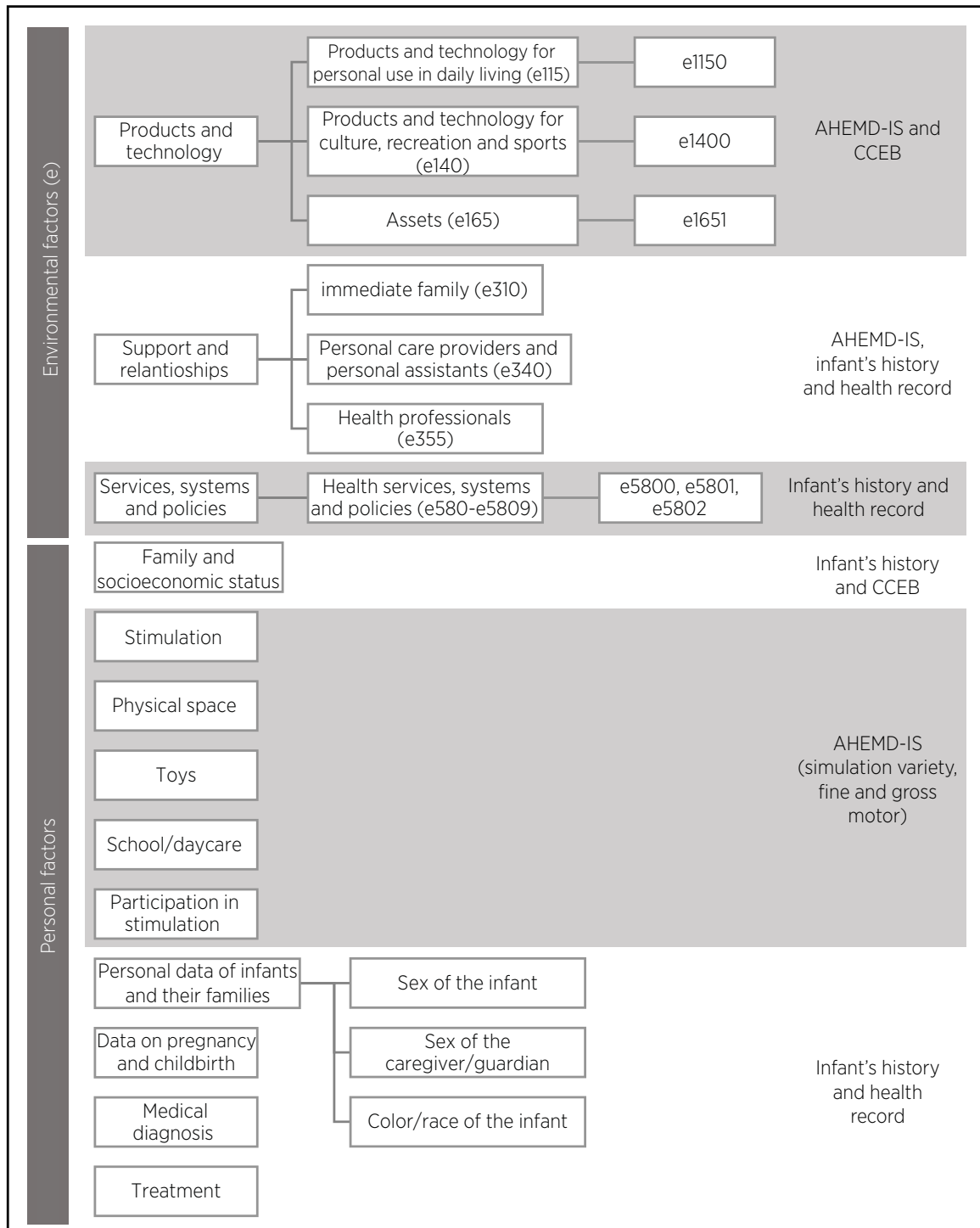
AHEMD-IS: Affordances in the Home Environment for Motor Development - Infant Scale; Bayley III: Bayley Scale of Infant and Toddler Development III; CD: cognitive domain; ELD: expressive language domain; RLD: receptive language domain; FMD: fine motor domain; GMD: gross motor domain.

Chart 2. Assessment tools that include activities and participation



CCEB: Brazilian Criteria of Economic Classification; AHEMD-IS: Affordances in the Home Environment for Motor Development - Infant Scale; Bayley III: Bayley Scale of Infant and Toddler Development III; CD: cognitive domain; ELD: expressive language domain; RLD: receptive language domain; FMD: fine motor domain; GMD: gross motor domain.

Chart 3. Assessment tools that include contextual factors



CCEB: Brazilian Criteria of Economic Classification; Bayley III: Bayley Scale of Infant and Toddler and Development III; AHEMD-IS: Affordances in the Home Environment for Motor Development - Infant Scale.

DISCUSSION

This study systematized and constructed a checklist with the tools for assessing child development according to the biopsychosocial model of ICF for infants exposed to HIV and ART in their first year of life. Importantly, it contemplated and favored a clinical reasoning model for better visualization

of the tools regarding the components of the functioning addressed by the scale or questionnaire, as well as the functions and structures, activities and participation, and environmental factors. The use of Bayley III, AHEMD-IS, CCEB, assessment form with information on the infant's history and booklet of infant's health responds and merges the categories of all components of the ICF.

The AHEMD-IS is a Brazilian self-report questionnaire answered by parents that addresses many stimulations, including everyday situations of the family environment that can encourage the infant to learn about the body parts by playing so that they can explore. Thus, the result regarding environmental factors can be justified by studies with infants at biological risk that associate many stimulations with an enriching environment, and the environment is the potentiator for motor development^{9,13}.

According to the bioecological theory of child development, the environment has four levels: microsystem, macrosystem, mesosystem, and exosystem¹⁵. Given the composition of the elements of the environmental systems of the infants evaluated (Figure 2), we can observe a link between the systems and the ICF components. In this perspective, the influence of the elements affects the infant because of the interaction with the environment.

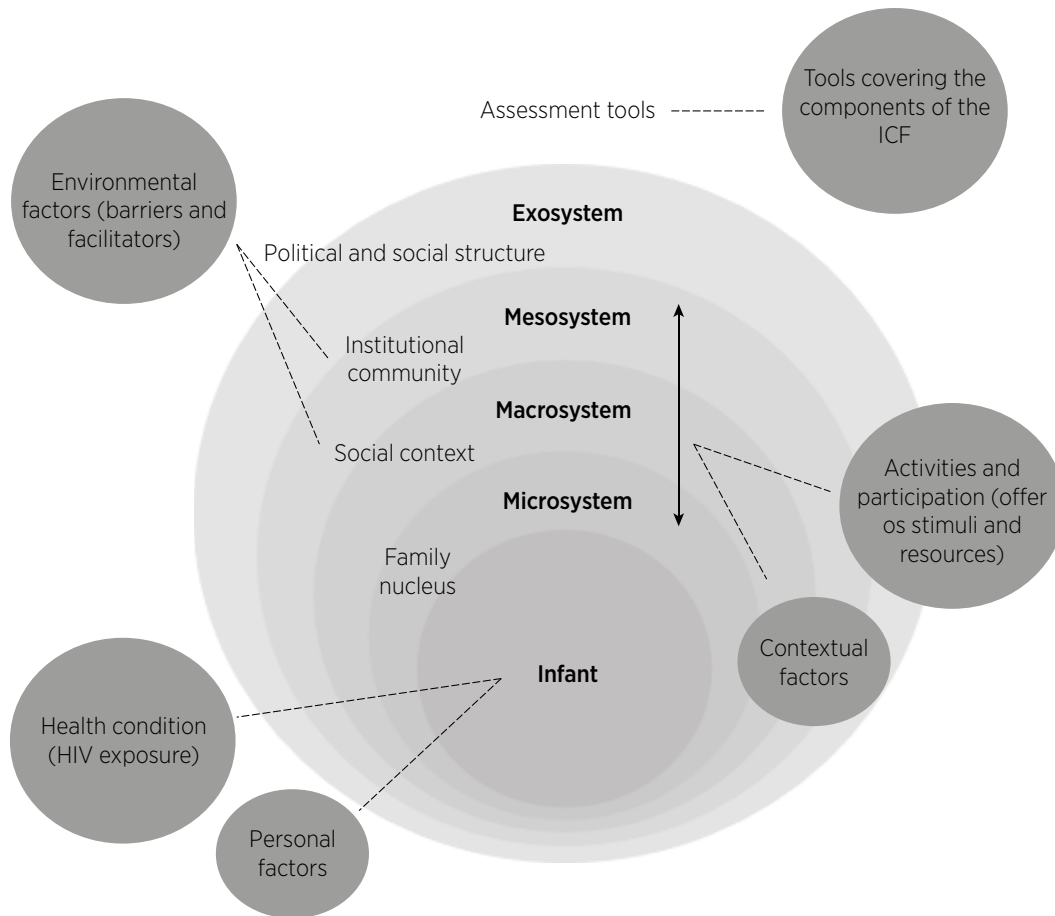


Figure 2. Representation of child development in the Bronfenbrenner model and the components of the International Classification of Functioning, Disability, and Health (ICF)

The systematization and checklist of child assessment tools according to the ICF model act as guides to broaden and create reasoning that goes beyond body functions and structure in infants exposed to HIV. Research on neuropsychomotor development of infants at biological risk for HIV exposure using Bayley III, considering the cognitive, motor, and language domains, showed the influence that environmental factors have on functioning, i.e., a multidirectional interaction of the environment with the components of activity and participation and body structure and function act as facilitators or barriers in capacities and/

or deficiencies^{9,16,17}. Moreover, studies assessing infants exposed to HIV showed lower scores in motor, cognitive, and language abilities up to 24 months of age when compared to those not exposed^{18,19}.

Activity corresponds to task execution or action the individual can perform, and the difficulties in this component are identified as limitations of the activity. Participation is the involvement/engagement of the individual in daily activities; changes in this domain are called participation restrictions¹. The components of activities and participation are represented by constructs of capacity and performance².

Private interpersonal relationships and *education* are associated with child development, especially in infants at biological risk, because higher maternal education favors greater engagement of infants in activities and consequently greater participation^{20,21}. Moreover, private interpersonal relationships, for example, mother-child bonding, can influence the development of infants exposed to HIV¹⁷. These results show the importance of interpersonal relationships and education for the child development of infants exposed to HIV. Also, in activities and participation, the *ability to perform activities* and *performance in participation* may be directly linked to biological factors of exposure to HIV and ART. On the other hand, *activity limitation* can be considered a delay in the acquisition and refinement of motor, cognitive, and language skills.

Home environmental factors, when associated with motor development, can affect the functioning components and motor capacities of infants^{5,9}. Studies have shown that these factors can act as facilitators or barriers to the development of motor skills and participation. Thus, resourceless home environments, a family with low purchasing power, and low parental education can be considered barriers to child development, as they are associated with an environment with few stimuli and opportunities for exploration and construction of the motor repertoire, inducing the lowest motor performance³. In short, since environmental factors can directly affect the infant's functioning or disability, the tools that contemplate the barriers or facilitators of this development are the CCEB and the AHEMD-IS, as well as the assessment form with the infant's history. The ICF does not present a classification regarding the infant's personal factors specifically, such as age, gender, socioeconomic status, life experiences, and others¹.

The results reinforce the importance of monitoring and surveillance of infants exposed to HIV and ART, because these infants may evolve with developmental delay and present deficiencies in body structure and function, limitations of activities, and restriction of their participation. We highlight the importance of assessing child development in their abilities integrated with environmental factors, the effect of these factors on the functioning and motor, cognitive, and language capacities of infants exposed to HIV and ART, especially in their first year of life.

We also highlight the importance of standardized tools for the assessment and identification of capacities and performance, that is, tools that include body structure and

functions, activities and participation, and environmental factors, identifying barriers or facilitators of the functioning of infants with biological risk. Activities and participation, as well as contextual factors, are important outcomes to be contemplated within an evaluation of the development of infants exposed to HIV. Moreover, environmental and personal factors can affect the components of the functioning, highlighting the need for a biopsychosocial assessment of infants at risk for VT of HIV in their first year of life.

CONCLUSION

This study brings important contributions to the assessment of child development of infants exposed to HIV and ART, by describing the assessment tools via different constructs and domains of the ICF and allowing the construction of clinical reasoning based on the perspective of functioning and surveillance of child development. Moreover, the study pointed out which areas of the ICF should be assessed in this population. The results obtained can be used as a checklist based on the ICF model.

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REFERENCES

1. OMS. Organização Mundial da Saúde; Organização Panamericana da Saúde. CIF: Classificação Internacional de Funcionalidade, Incapacidade e Saúde. São Paulo: Edusp; 2020.
2. Adolph KE, Franchak JM. The development of motor behavior. *Wiley Interdiscip Rev Cogn Sci*. 2017;8(1-2):e1430. doi: 10.1002/wcs.1430.
3. Cunha AB, Miquelote AF, Santos DCC. Motor affordance at home for infants living in poverty: a feasibility study. *Infant Behav Dev*. 2018;51:52-9. doi: 10.1016/j.infbeh.2018.03.002.
4. Yousafzai AK. If not now, then when? The importance of intervening early to provide family-based environments for all children. *Lancet Child Adolesc Health*. 2020;4(8):565-66. doi: 10.1016/S2352-4642(20)30187-5.
5. Sacconi R, Valentini NC, Pereira KR, Müller AB, Gabbard C. Associations of biological factors and affordances in the home

- with infant motor development. *Pediatr Int.* 2013;55(2):197-203. doi: 10.1111/ped.12042.
6. Sirois A, Huo Y, Williams PL, Malee K, Garvie PA, et al. Safety of perinatal exposure to antiretroviral medications: developmental outcomes in infants. *Pediatr Infect Dis J.* 2013;32(6):648-55. doi: 10.1097/INF.0b013e318284129a.
 7. Ministério da Saúde (BR). Boletim epidemiológico: HIV/AIDS 2021. Brasília (DF): Ministério da Saúde; 2021 [cited 2022 Jan 30]. Available from: <https://www.gov.br/saude/pt-br/centrais-de-conteudo/publicacoes/boletins/epidemiologicos/especiais/2021/boletim-epidemiologico-especial-hiv-aids-2021.pdf>
 8. Novak I, Morgan C. Chapter 23 – High-risk follow-up: early intervention and rehabilitation. In: de Vries LS, Glass HC. Neonatal neurology. Amsterdam: Elsevier; 2019. p. 483-510. (Handbook of Clinical Neurology; vol. 162).
 9. Corrêa FR, Pádua RF, Sá CSC. Affordances and development of HIV-exposed and unexposed infants. *Temas em Saúde.* 2020;20(4):7-28. doi: 10.29327/213319.20.4-1.
 10. Araujo LB, Novakoski KRM, Bastos MSC, Mélo TR, Israel VL. Caracterização do desenvolvimento neuropsicomotor de crianças até três anos: o modelo da CIF no contexto do NASF. *Cad Bras Ter Ocup.* 2018;26(3):538-57. doi: 10.4322/2526-8910.ctoAO1183.
 11. Nguyen L, Cross A, Rosenbaum P, Gorter JW. Use of the International Classification of Functioning, Disability and Health to support goal-setting practices in pediatric rehabilitation: a rapid review of the literature. *Disabil Rehabil.* 2021;43(6):884-94. doi: 10.1080/09638288.2019.1643419.
 12. Bayley N. Bayley scales of infant development. 3rd ed. San Antonio: Psychological Corporation; 2006.
 13. Caçola PM, Gabbard C, Montebelo MIL, Santos DCC. The new affordances in the home environment for motor development-infant scale (AHEMD-IS): versions in English and Portuguese languages. *Braz J Phys Ther.* 2015;19(6):507-25. doi: 10.1590/bjpt-rbf.2014.0112.
 14. Associação Brasileira de Empresas de Pesquisa. Critério de Classificação Econômica Brasil [Internet]. São Paulo: ABEP; 2018 [cited 2022 Jan 30]. Available from: <https://www.abep.org/criterio-brasil>
 15. Bronfenbrenner U. Ecology of the family as a context for human development: research perspectives. *Dev Psychol.* 1986;22(6):723-42. doi: 10.1037/0012-1649.22.6.723.
 16. Neves FC, Sá CSC. Desenvolvimento de lactentes expostos e não expostos ao HIV: estudo longitudinal. *Temas em Saúde.* 2020;20(1):498-518. doi: 10.29327/213319.20.1-28.
 17. Pádua RF, Ruivo CO, Sá CSC. Ambiente domiciliar, vínculo mãe-filho e o desenvolvimento de lactentes expostos e não expostos ao vírus da imunodeficiência humana. *Temas em Saúde.* 2020;20(2):267-85. doi: 10.29327/213319.20.2-15.
 18. Strehlau R, van Aswegen T, Burke M, Kuhn L, Potterton J. A description of early neurodevelopment in a cohort of HIV-exposed uninfected children. *AIDS Care.* 2020;32(11):1421-8. doi: 10.1080/09540121.2020.1736257.
 19. Jao J, Kacanek D, Yu W, Williams PL, Patel K, Burchett S, et al. Neurodevelopment of HIV-exposed uninfected infants born to women with perinatally acquired HIV in the United States. *J Acquir Immune Defic Syndr.* 2020;84(2):213-9. doi: 10.1097/QAI.0000000000002318.
 20. Herrero D, Gallo PR, Fujimori M, Monteiro CBM, Valenti VE, et al. Motor development of infants exposed to maternal human immunodeficiency virus (HIV) but not infected. *Int Arch Med.* 2013;6(1):45. doi: 10.1186/1755-7682-6-45.
 21. Valadi S, Gabbard C, Hooshyari F. Effects of affordances in the home environment on children's personal-social, problem-solving, and communication skills. *Child Care Health Dev.* 2020;46(4):429-35. doi: 10.1111/cch.12756.