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Systematic review and meta-analysis

Child development assessment in Latin American countries: A systematic review

Avaliação de desenvolvimento infantil em países da América Latina: Revisão sistemática

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Abstract

The present study aimed to systematically review empirical studies on early childhood development assessments in Latin American countries (LACs). The focus was to identify the instruments used to evaluate the development of 0-to-6-year-old children, summarize the main findings, and examine their methodological quality. A systematic search identified 28 articles conducted predominantly in Brazil, Colombia, Peru, Chile, and Argentina. Most studies were cross-sectional and had case-control designs. Child and maternal health conditions were predominantly examined in association with child development. We identified 16 different instruments used for evaluation and screening tests predominated. Denver II and Bayley scales were the most used tools. Cultural validation and standardization of the instruments should be achieved through further investment in LACs, to identify developmental risks or delays for better informed decision-making on prevention and treatment strategies for protecting child development.

Keywords: Development. Early childhood. Assessment. Latin America. Systematic review.

Resumo

O presente estudo teve por objetivo realizar uma revisão sistemática dos estudos empíricos sobre avaliação do desenvolvimento na primeira infância nos países da América Latina. O foco foi identificar os instrumentos utilizados para avaliar o desenvolvimento de crianças de 0 a 6 anos, sintetizar os principais achados e examinar sua qualidade metodológica. Foram encontrados 28 artigos conduzidos predominantemente no Brasil, Colômbia, Peru, Chile e Argentina. A maioria dos estudos era transversal de caso-controle. Nos estudos, condições de saúde da criança e da mãe foram especialmente examinadas em associação com o desenvolvimento infantil. Foram identificados 16 diferentes instrumentos, predominando testes de triagem. As escalas Denver II e Bayley foram os instrumentos mais utilizados. A validação cultural e padronização dos instrumentos deve ser alcançada com investimentos adicionais nos países latinos, a fim de identificar riscos ou atrasos no desenvolvimento, para uma tomada de decisão sobre estratégias de prevenção e tratamento mais bem fundamentada.

Palavras-chave: Desenvolvimento. Primeira infância. Avaliação. América Latina. Revisão sistemática.

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Introduction

Early childhood is a critical period with short-, medium-, and long-term impacts on individuals' developmental achievements (Lipkin et al., 2020a; Shonkoff et al., 2012; Shonkoff & Fisher, 2013). Strong scientific evidence has demonstrated that the first six years of life is the optimal period of human development – the so-called "window of opportunities," which impacts developmental, social, and economic aspects until adulthood (Engle et al., 2011; Shonkoff, 2010; Walker et al., 2011). At an early age, children present high brain plasticity with great potential for development (Fandakova & Hartley, 2020; Kolb & Gibb, 2011). In this sense, children need appropriate care and environmental stimulation to promote learning and good performance in several developmental domains, including gross and fine motor coordination, language, and the affective and social domains (Sania et al., 2019; Shonkoff et al., 2012).

However, unfortunately, as consistently demonstrated by three relevant serial Lancet`s publications released in 2007, 2011 and 2017, children living in low- and medium- income countries (LMICs) have not been reaching their full potential of development in their first five years of life due to exposure to multiple adversities (Black et al., 2017; Engle et al., 2007; Grantham-McGregor et al., 2007). Poverty, health problems, nutrition insecurity, violence, poor parental care, and learning restrictions are the main risk factors that impact children's development (Black et al., 2017; Engle et al., 2011; Grantham-McGregor et al., 2007). To cope with such undesirable developmental losses, the implementation of protective mechanisms is urgently required to prevent and reduce the negative impacts of these risks on child developmental trajectories (Sameroff, 2006; Walker et al., 2011). Additionally, developmental problems should be detected in early childhood to reduce the high rate of non-referral to specialists and ensure children receive appropriate treatment (Jimenez et al., 2014).

To accomplish protective actions for childhood development, the child assessment procedure is recommended for early identification of developmental risks, delays, or disabilities that require opportune interventions to guarantee children well-being, quality of life, and the requisite tools for psychological adaptation (Fernald et al., 2017; Lipkin et al., 2020a). There are different types of child development evaluation processes that vary according to their intended purpose. The screening assessment uses standardized tools to identify risks related to child development in specific or all domains at key stages of development by age; the surveillance evaluation recognizes children at risk for developmental disorders and supervises them longitudinally at more frequent intervals than general methods for risk-tracking (e.g., home visits or medical consultation in primary care contexts). Moreover, the diagnostic employed is a more complex and specialized clinical evaluation of developmental disorders and their impacts on physical and psychological function limitations. Specifically, it aims to refer children to specialists for special education, counseling, and/or therapeutic services (Lipkin et al., 2020b). Regarding child developmental assessment protocols, it is important to answer the following questions: "*What will be assessed?*" (e.g., global development, specific domains), "*How will it be assessed?*" (e.g., screening, surveillance, or diagnostic evaluations), and "*What purposes(s) will the assessment serve?*" (e.g., risk identification, longitudinal monitoring of risks, or clinical identification to refer children to therapeutic intervention) (Fernald et al., 2009, 2017).

Previous systematic reviews have summarized the findings of early child development evaluation studies conducted in LMICs (Albuquerque & Cunha, 2020; Munoz-Chereau et al., 2021). The first exclusively analyzed screening studies which were conducted in a specific Latin American country (Brazil) and identified four predominant tools: the Denver Developmental Screening Test II, the Ages and Stages Questionnaire, the Bayley Scales of Infant and Toddler Development Screening Test, and the Battelle Developmental Inventory Screening Test (Albuquerque & Cunha, 2020). The second review examined studies that exclusively assessed the cognitive development domain and learning environmental contexts of children in LMICs, from which a total of 43 tools were detected that had more linguistic than appropriate cultural equivalence (Munoz-Chereau et al., 2021).

To the best of our knowledge, there remains a gap in the literature regarding the systematic review of empirical studies performed exclusively in Latin American countries for all child development domains assessed using screening, surveillance, or diagnostic tools.

Therefore, the present study aims to systematically review empirical studies that have evaluated early childhood development in Latin American countries through developmental surveillance, screening, or diagnostic procedures. The current review was guided by the following questions: (*i*) Which instruments were used to assess early childhood development, considering their purpose (screening, surveillance, or diagnosis tools) and main features? (*ii*) What are the psychometric qualities of the instruments and their cultural validity in Latin American countries? (*iii*) What are the main findings of such studies? and (*iv*) What was the methodological quality of the reviewed studies?

Method

The review study was registered in *PROSPERO* (CRD42021264153).

Data search

The present review was conducted through the search and selection of scientific articles according to the process recommended by the PRISMA-Preferred Reporting Items for Systematic Reviews and Meta-Analyses (Liberati et al., 2009). The following databases were searched: PubMed, Web of Science, PsycINFO, Scopus, LILACS, and the electronic library SciELO. Empirical studies published in English, Spanish or Portuguese, with prospective or retrospective designs published from January 2016 to February 2022 were included. The search period was selected to cover the most recent publications on early childhood development assessment. Only one article was found in the queried databases in 2016, but the number of publications increased thereafter, particularly in 2019 and 2020. The first search was conducted in April 2021 and updated in February 2022 to include three new articles.

The final search used these terms: ((child* development*) AND (assessment OR evaluation OR screening) AND ("low-income countries" OR "medium-income countries" OR "middle-income countries" OR "low- and medium-income countries" OR "low- and middle-income countries" OR "low-income country" OR "middle-income country" OR "medium-income country" OR "low- and middle-income country" OR "low- and medium-income country")). In the LILACS and SciELO data bases, we used the search in Spanish and Portuguese languages, respectively.

Inclusion and exclusion criteria

The inclusion criteria were the following: (*i*) empirical studies that assessed child development in samples from Latin American; (*ii*) studies with children from 0 to 6 years of age (early childhood); (*iii*) studies published from January 2016 to February 2022; (iv) studies in English, Spanish or Portuguese languages. The exclusion criteria were as the follows: (*i*) studies without psychometric instruments to assess child development; (*ii*) intervention studies; (*iii*) conceptual theoretical studies, guidelines, protocols, reports, recommendations, editorials, case studies, documents, synthesis, guide, comments, guidelines, and summaries; (*iv*) psychometric or instrument comparison studies; (*v*) studies with analysis in secondary databases.

Data screening and selection

All initially identified articles were included in the Rayyan software (Ouzzani et al., 2016), which was used as a support tool to identify duplicate articles in different databases and to classify articles included or excluded in the analysis of titles and abstracts.

As shown in Figure 1, a total of 2,050 articles were initially identified in the databases, 267 of which were duplicates and excluded. Thus, 1,783 studies were subsequently screened based on the inclusion and exclusion criteria. Of these studies, 1,746 were excluded after reading the titles and abstracts. The remaining 37 articles were eligible for inclusion in the review. However, an additional nine studies were excluded in the next step, considering that the intervention studies did not present child development data in the baseline. The final sample comprised 28 articles.

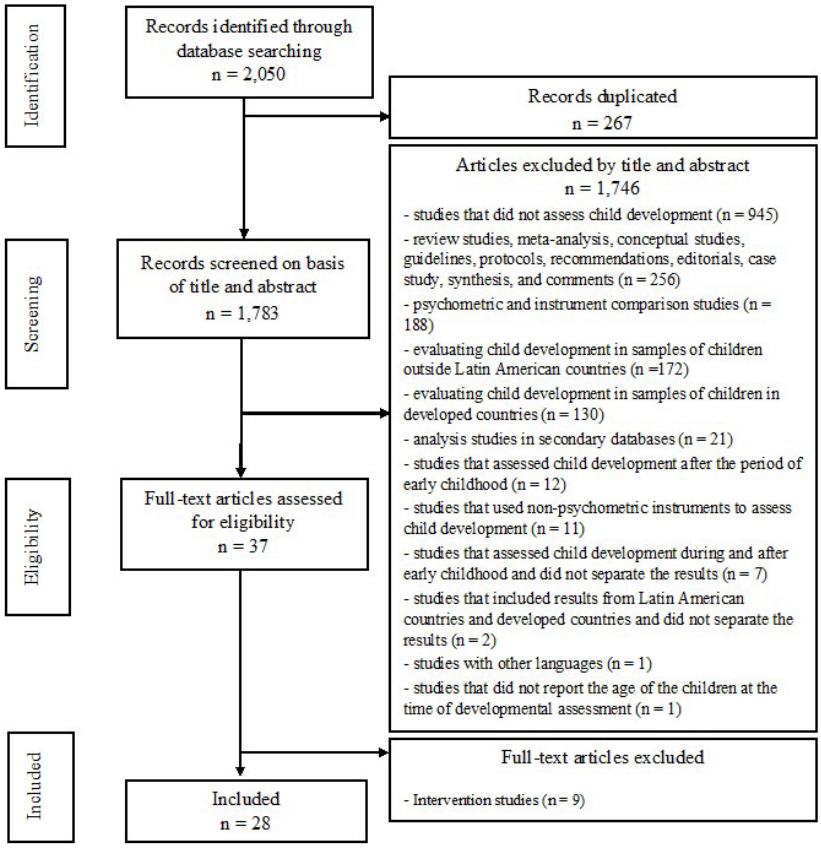

Figure 1. Flowchart of article selecting process.

Data extraction

The selected articles were reviewed, analyzed, and coded according to the following items: study location and setting, study design, study objective, sample, information about instruments used in developmental assessments (validation, type, applicability, and cost), variables related to child development, and the main findings of the study. The first author read all articles and performed data extraction coding according to these items. They were then reviewed by the second and last authors to ensure the accuracy of the analysis.

Methodological analysis of the studies

Von Elm et al.'s (2008) Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) was used to assess the methodological quality of the studies included in this review. STROBE presents a checklist for observational study design composed of the following 28 items: title and abstract, introduction (background and objectives), method (study design, setting, participants, variables, measurement, bias, study size, quantitative variables, and data analysis), results (participants, descriptive data, outcome data, main results, and other analyses), discussion (key results, limitations, interpretations, and generalizability), and other information (funding). The STROBE Index was established to determine the percentage of items achieved. The score for each study was calculated as the sum of these 28 items (0-28), wherein higher total scores indicate greater methodological quality.

Results

Overview of the studies

Of the 28 studies reviewed, 19 were conducted in Brazil (68%), four in Colombia (14%), three in Peru (10%), and Argentina and Chile contributed only one article each. It is important to note that one multicenter study (Dearden et al., 2017) was performed in four different countries, of which only one was in Latin America (Peru).

Concerning design, most studies were cross-sectional (n = 21; 75%), and involved case-control (n = 8; 38%). It is important to note that some cross-sectional studies were nested in previous cohort studies and analyzed specific subsamples of them (n = 5; 24%). Among the prospective-longitudinal studies (n= 7; 25%), cohort studies were the minority (n = 2; 28%).

There was a broad range of sample sizes in the studies, the smallest and largest being 14 and 3,776 participants, respectively, with a mean of 779 participants. Most studies included both genders in approximately the same proportion (52% boys / 48% girls). One study was only conducted on girls (Lamônica et al., 2020) and three others did not identify the children's gender (Lerma Castaño et al., 2020; Muñoz et al., 2017; Pereira et al., 2018). Most studies included infants aged 0 to 3 years (58%), followed by studies with children aged 3 to 6 years (21%), and children aged less than 1 year to 6 years (21%).

Table 1 present the instruments for early childhood development assessment used in the studies reviewed. The child development domains assessed as primary outcomes were motor (n = 25, 89%) and language, communication, lexical, or vocabulary (n = 21, 75%). The intelligence domain had the lowest prevalence among the studies (n = 3, 11%). Most of the studies evaluated more than one developmental domain (n = 24; 86%) and used a single instrument for assessment (n = 21; 75%). The most common type of instrument used was a screening test (n = 26; 93%), as opposed to a diagnostic instrument.

We detected 15 different instruments, including two that had different versions. The most frequently used instrument to assess the development of Latin American children was the Denver Developmental Screening Test (DDST-II), followed by the Bayley Scales of Infant and Toddler Development (versions II and III) for both screening and diagnostic purposes.

The Ages and Stages Questionnaire-III (ASQ-III) was the third most used instrument, observed in five studies from Brazil and Peru (18%). The Peabody Picture Vocabulary Test (PPVT), applied in studies from Colombia, and the Abbreviated Development Scale (*Escala Abreviada de Desarrollo*, EAD), in its first or third edition, employed in studies from Brazil and Peru, were used in three studies each. Two studies conducted in Brazil and Colombia used the International Development and Early Learning Assessment (IDELA). Other instruments were found in one study each: an assessment scale of psychomotor development (EEDP), the Intergrowth-21st Neurodevelopment Assessment (INTER-NDA), the Survey of Well-being of Young Children (SWYC), the MacArthur Communicative Development Inventory, the Argentine Scale of Sensorimotor Intelligence (EAIS), the Regional Project on Child Development Indicators (PRIDI), the Test of Sensory Functions in Infants (TSFI), the Stanford-Binet Intelligence Scale (SBIS), and the Wechsler Preschool and Primary Scale of Intelligence (WPPSI). Finally, six studies combined two or more instruments for child development assessment: in Argentina, EEDP and EAIS; in Chile, Bayley and WPPSI; in Brazil, Denver II and MacArthur; Bayley and TSFI; Denver II, PPVT, and SBIS; PRIDI and IDELA.

Methodological quality of the studies

Table 2 shows that most studies (n=27; 96%) achieved a minimum rating of 50% on the STROBE index. In addition, eight studies (28%) showed a high index score of ≥ 75%, indicating excellent methodological care. Only one study had weak methodological quality, as indicated by a score of under 50%. The most frequent weaknesses detected in the study reports were as follows: missing data in variables of interest (n = 24; 86%); lack of models adjusted by confounding factors (n = 23; 82%); no diagram showing participants in each phase of the study and missing data (n = 22; 78%); absence of specificity regarding all measures adopted to avoid potential sources of bias (n = 21; 75%); no description of statistical treatment for missing data (n = 21; 75%); and no description of the study design in the title or abstract.

Main findings of the studies

The main findings were organized into five topics corresponding to the studies reviewed and developed in Latin American countries (Brazil, Colombia, Peru, Chile, and Argentina). Table 3 presents the findings of child development evaluations in the 19 Brazilian studies while Table 4 shows the findings of nine other Latin American countries' studies.

Table 1. Instruments for early childhood development assessment.

Instrument	Child development domains	n articles	Type of tool / Cost	References
Denver II	personal-social, fine motor-adaptive, language, and gross motor	7	Screening / $	Alencar et al. (2017) Cavalheiro et al. (2019) Lamônica et al. (2020) Pereira et al. (2018) Ribeiro et al. (2017) Silva et al. (2018) Yamaguchi et al. (2019)
Bayley-III Screening Test	motor, cognition, and language	4	Screening / $$$	Frezzato et al. (2017) Machado et al. (2019) Okido et al. (2020) Silva et al. (2017)
Bayley-II* / Bayley-III	cognitive, receptive- and expressive-language, fine- and gross-motor, socioemotional, and adaptive behavior	2	Diagnostic / $$$	Gerzson et al. (2020) de la Parra et al. (2017)*
ASQ-3	communication, gross motor, fine motor, problem solving, and personal-social	5	Screening / $	Bertolli et al. (2020) Correia et al. (2019) Fink et al. (2018) Fonseca Filho et al. (2021) Muñoz et al. (2017)
EAD-1* / EAD-3	gross motor, adaptive fine motor, hearing- language, social-personal	3	Screening /$	Lerma Castaño et al. (2019) Lerma Castaño et al. (2020) Pacheco et al. (2021)*
PPVT	lexical development	3	Screening / $$	Bendini & Dinarte (2020) Dearden et al. (2017) Lamônica et al. (2020)
IDELA	numeracy, literacy, language, social-emotional, motor, executive functions	2	Screening / Free	Raess et al. (2022) Rey-Guerra et al. (2022)
EEDP	social, language, coordination, and motor	1	Screening /$	Romero et al. (2019)
INTER-NDA	cognition, language, motor, behaviour, attention, and socio-emotional reactivity	1	Screening / Free	Neves et al. (2020)
SWYC	cognition, language, motor	1	Screening / Free	Silva et al. (2020)
MacArthur	vocabulary checklist	1	Screening / $$	Cavalheiro et al. (2019)
EAIS	sensorimotor intelligence	1	Screening / $	Romero et al. (2019)
PRIDI	cognition, language, socioemotional, motor	1	Screening tool / Free	Raess et al. (2022)
SBIS	intelligence	1	Screening tool / $$$	Lamônica et al. (2020)
WPPSI	intelligence	1	Screening tool / $$$	de la Parra et al. (2017)
TSFI	sensory processing	1	Screening tool / $$$	Machado et al. (2019)

Note: Denver II = Denver II Developmental Screening Test; Bayley-II = Bayley Scales of Infant and Toddler Development Second Edition; Bayley-III = Bayley Scales of Infant and Toddler Development Third Edition; ASQ-3 = Ages and Stages Questionnaire III; EAD-1 = Escala Abreviada de Desarrollo First Edition; EAD-3 = Escala Abreviada de Desarrollo Third Edition; PPVT = Peabody Picture Vocabulary Test; IDELA = International Development and Early Learning Assessment; EEDP = Escala de Evaluación del Desarrollo Psicomotor; INTER-NDA = INTERGROWTH-21st Neurodevelopment Assessment; SWYC = Survey of Well-being of Young Children; MacArthur = MacArthur Communicative Development Inventory; EAIS = Escala Argentina de Inteligencia Sensoriomotriz; PRIDI = Regional Project on Child Development Indicators; SBIS = Stanford-Binet Intelligence Scale; WPPSI = Wechsler Preschool and Primary Scale of Intelligence; TSFI = Test of Sensory Functions in Infants; * = Bayley-II.

Table 2. Methodological care of the studies reviewed, based on STROBE Statement.

Methodological Care (STROBE Index level)	References	%
≥ 75%	Raess et al. (2022)	97
	Neves et al. (2020)	91
	Okido et al. (2020)	90
	Pereira et al. (2018)	84
	Silva et al. (2020)	82
	Correia et al. (2019); Dearden et al. (2017)	77
	Machado et al. (2019)	76
74%-50%	Gerzson et al. (2020)	72
	Lerma Castaño et al. (2019)	71
	Pacheco et al. (2021)	70
	Silva et al. (2017, 2018)	69
	Fonseca Filho et al. (2021); Romero et al. (2019)	68
	Fink et al. (2018)	65
	Bertolli et al. (2020); Frezzato et al. (2017)	64
	Rey-Guerra et al. (2022)	63
	Alencar et al. (2017)	59
	de la Parra et al. (2017)	58
	Bendini & Dinarte (2020); Lamônica et al. (2020); Yamaguchi et al. (2019)	55
	Ribeiro et al. (2017)	52
	Cavalheiro et al. (2019); Muñoz et al. (2017)	50
< 50%	Lerma Castaño et al. (2020)	45

Note: % = percentage of STROBE Index level (Von Elm et al., 2008).

Table 3. Summary of the main findings of child development assessment, in Brazil (n = 19).

Author/ Year	Study design/ Data analysis	Sample	Primary outcomes: Child development domains/ Age of children	Instruments/ Measures/ Translation/ Cultural adaptation (Yes/No/NI)	Predictors, independent variables or secondary outcomes/ Measures	Main Findings (Child Development)
Child development evaluated by Denver II (n = 7 studies)						
Alencar et al. (2017)	Cross-sectional study/ Between-group comparison	n = 62 children (53% girls) *Groups:* NPI treatment = 38; Postural treatment = 24 *SES level:* NI *Ethnicity*: NI *Source of recruitment*: University hospital	Motor (fine and gross), personal-social, and language (2 to 6y)	Denver II / classification / NI / NI	*Infant's characteristics:* Type of treatment (NPI or Postural) / medical records Neurological development / NEE	NS (both groups normal development)

Note: SES = Socioeconomic Status; NS = Non-significant statistically; NI = Not informed; Denver II = Denver II Development Screening Test; NPI = Nasopharyngeal Intubation; NEE = Neurological Evolutionary Examination; CLP = Cleft Lip and Palate; CG = Control Group; MacArthur = MacArthur Communicative Development Inventory; CH = Congenital Hypothyroidism; PPVT-R = Peabody Picture Vocabulary Teste – Revised; SBIS = Stanford-Binet Intelligence Scale; SMM = Severe Maternal Morbidity; ASSIST = Alcohol, Smoking and substance Involvement Screening Test 2.0; PT = Preterm; FT = Full Term; LBW = Low Birth Weight; VLBW = Very Low Birth Weight; CEC = Child Education Center; ZIKV = Zika Virus; TSFI = Test of Sensory Functions in Infants; UtA-PI = Uterine artery pulsatility index; Bayley-III = Bayley Scales of Infant and Toddler Development III; ASQ-3 = Ages and Stages Questionnaire Third Edition; HINE = Hammersmith Infant Neurological Examination; IBGE = Instituto Brasileiro de Geografia e Estatística; USDA = United States Department of Agriculture; HAZ = height-for-age; WAZ = weight-for-age; KM = Kangaroo Method; INTER-NDA = INTERGROWTH-21st Neurodevelopment Assessment; PRIDI = Regional Project on Child Development Indicators; IDELA = International Development and Early Learning Assessment; SWYC = Survey of Wellbeing of Young Children; SGA = Small for Gestational Age.

Table 3. Continued...

Author/ Year	Study design/ Data analysis	Sample	Primary outcomes: Child development domains/ Age of children	Instruments/ Measures/ Translation/ Cultural adaptation (Yes/No/NI)	Predictors, independent variables or secondary outcomes/ Measures	Main Findings (Child Development)
Cavalheiro et al. (2019)	Cross-sectional, case-control study / Between group comparison	n = 60 infants (53% boys); *Groups:* CLP = 30 non-syndromic repaired CLP; CG = 30 typical development *SES level*: middle and lower middle *Ethnicity*: NI *Source of recruitment*: Rehabilitation hospital	Motor (fine and gross), personal-social, and language (36 to 47m)	Denver II/ classification/ NI / NI MacArthur / classification/ NI / NI	*Infant's characteristics:* Non-syndromic CLP / medical assessment	CLP: 23,4% expected development and 76,6% at risk to developmental delay (mainly in language: 69,5%) Motor and language: CLP < CG; Personal-social: NS
Lamônica et al. (2020)	Cross-sectional, case-control study / Between-group comparison	n = 30 girls *Groups:* CH = 15; CG = 15 *SES level:* 53.34%, lower-middle level *Ethnicity*: NI *Source of recruitment*: Faculty of Odontology	Motor (fine and gross), personal-social, and language Lexical development in the auditory-receptive vocabulary Intelligence (38 to 70m)	Denver II / classification / NI / NI PPVT-R / score / NI / NI SBIS / score / NI / NI	*Family conditions:* Education and socioeconomic status / Brazilian Socioeconomic Classification Criteria	Intelligence, motor and language: CH < CG (within the normal range/normal classification)
Pereira et al. (2018)	Cross-sectional study (nested in a cohort) / Between-group comparison	n= 638 mothers and their children *Groups*: With SMM = 315; Without SMM = 323 *SES level:* C, D and, E levels = 59% *Ethnicity*: White = 45% *Source of recruitment*: Center of Integral Assistance to Women`s Health	Motor (fine and gross), personal-social, and language (6m to 5y)	Denver II/ classification/ NI / NI	*Maternal factors:* Use of substances / ASSIST SMM during pregnancy, delivery and postpartum / medical records	Use of tobacco and cocaine → child developmental delay (from 6m to 5y)

Note: SES = Socioeconomic Status; NS = Non-significant statistically; NI = Not informed; Denver II = Denver II Development Screening Test; NPI = Nasopharyngeal Intubation; NEE = Neurological Evolutionary Examination; CLP = Cleft Lip and Palate; CG = Control Group; MacArthur = MacArthur Communicative Development Inventory; CH = Congenital Hypothyroidism; PPVT-R = Peabody Picture Vocabulary Teste – Revised; SBIS = Stanford-Binet Intelligence Scale; SMM = Severe Maternal Morbidity; ASSIST = Alcohol, Smoking and substance Involvement Screening Test 2.0; PT = Preterm; FT = Full Term; LBW = Low Birth Weight; VLBW = Very Low Birth Weight; CEC = Child Education Center; ZIKV = Zika Virus; TSFI = Test of Sensory Functions in Infants; UtA-PI = Uterine artery pulsatility index; Bayley-III = Bayley Scales of Infant and Toddler Development III; ASQ-3 = Ages and Stages Questionnaire Third Edition; HINE = Hammersmith Infant Neurological Examination; IBGE = Instituto Brasileiro de Geografia e Estatística; USDA = United States Department of Agriculture; HAZ = height-for-age; WAZ = weight-for-age; KM = Kangaroo Method; INTER-NDA = INTERGROWTH-21st Neurodevelopment Assessment; PRIDI = Regional Project on Child Development Indicators; IDELA = International Development and Early Learning Assessment; SWYC = Survey of Wellbeing of Young Children; SGA = Small for Gestational Age.

Table 3. Continued...

Author/ Year	Study design/ Data analysis	Sample	Primary outcomes: Child development domains/ Age of children	Instruments/ Measures/ Translation/ Cultural adaptation (Yes/No/NI)	Predictors, independent variables or secondary outcomes/ Measures	Main Findings (Child Development)
Ribeiro et al. (2017)	Cross-sectional, case-control study / Between-group comparison	n = 150 children PT and FT (51% girls) *Groups*: At 1 to 2y: EG-I = 20 PT LBW; CG-I = 20 FT; EG-II = 19 PT VLBW; CG-II=19 FT At 2 to 3y: EG-III = 20 PT LB; CG-III=20FT; EG-IV=16PTVLBW; CG-IV = 16 FT *SES level:* 61% B-level *Ethnicity*: NI *Source of recruitment*: NI	Motor (fine and gross), personal-social, and language (1 to 3y)	Denver II/ classification / NI / NI	*Infant's characteristics:* gestational age and birth weight / medical records	Gross and fine motor, personal-social, and language: EC-I < CG-I; EG-II < CG-II; EG-III < CG-III; EG-IV < CG-IV
Silva et al. (2018)	Cross-sectional study/ Between-group comparison	n = 318 children (56% boys) *SES level:* 65% 1 to 3 minimum wages *Ethnicity*: NI *Source of recruitment*: child education units	Motor (fine and gross), personal-social, and language (36 to 48m)	Denver II / classification / Yes / No	*Infant's characteristics:* Gender / questionnaire	Fine motor, language, and personal-social: girls > boys Gross motor: boys > girls
Yamaguchi et al. (2019)	Cross-sectional study / Between-group comparison and Regression analysis	n = 444 children (53% boys) *Groups:* Partial-time in CEC= 239; Full-time in CEC = 205 *SES level:* NI *Ethnicity*: NI *Source of recruitment*: two towns	Motor (fine and gross), personal-social, and language (0 to 5y)	Denver II / classification / NI / No	*Infant's characteristics:* CEC attendance period, age, gender / questionnaire	54% developmental risk; 45.9% developmental risk in at least one domain (higher for personal-social and language domains) ↑Age → ↓ Risk of questionable development Partial-time and boys → ↑risk for questionable development

Note: SES = Socioeconomic Status; NS = Non-significant statistically; NI = Not informed; Denver II = Denver II Development Screening Test; NPI = Nasopharyngeal Intubation; NEE = Neurological Evolutionary Examination; CLP = Cleft Lip and Palate; CG = Control Group; MacArthur = MacArthur Communicative Development Inventory; CH = Congenital Hypothyroidism; PPVT-R = Peabody Picture Vocabulary Teste – Revised; SBIS = Stanford-Binet Intelligence Scale; SMM = Severe Maternal Morbidity; ASSIST = Alcohol, Smoking and substance Involvement Screening Test 2.0; PT = Preterm; FT = Full Term; LBW = Low Birth Weight; VLBW = Very Low Birth Weight; CEC = Child Education Center; ZIKV = Zika Virus; TSFI = Test of Sensory Functions in Infants; UtA-PI = Uterine artery pulsatility index; Bayley-III = Bayley Scales of Infant and Toddler Development III; ASQ-3 = Ages and Stages Questionnaire Third Edition; HINE = Hammersmith Infant Neurological Examination; IBGE = Instituto Brasileiro de Geografia e Estatística; USDA = United States Department of Agriculture; HAZ = height-for-age; WAZ = weight-for-age; KM = Kangaroo Method; INTER-NDA = INTERGROWTH-21st Neurodevelopment Assessment; PRIDI = Regional Project on Child Development Indicators; IDELA = International Development and Early Learning Assessment; SWYC = Survey of Wellbeing of Young Children; SGA = Small for Gestational Age.

Table 3. Continued...

Author/ Year	Study design/ Data analysis	Sample	Primary outcomes: Child development domains/ Age of children	Instruments/ Measures/ Translation/ Cultural adaptation (Yes/No/NI)	Predictors, independent variables or secondary outcomes/ Measures	Main Findings (Child Development)
Child development evaluated by Bayley-III (n = 5 studies)						
Frezzato et al. (2017)	Cross-sectional, case-control study / Between-group comparison and Regression analysis	n = 168 children (55% boys) *Groups:* CH = 117; CG = 51 *SES level:* NI *Ethnicity*: NI *Source of recruitment*: Neonatal Reference Screening Service, Rehabilitation Center and daycare centers	Motor, cognition and language (1 to 42 m)	Bayley-III Screening Test / classification / NI / NI	*Infant's characteristics:* CH criteria / medical records	Gross and fine motor: CH < CG (for competent) CH: ↑Fine motor→↑Language
Gerzson et al. (2020)	Cross-sectional, case-control study / Between-group comparison	n = 37 children (65% boys) *Groups:* ZIKV (normocephalic children from mothers infected during pregnancy) = 17; CG (normocephalic children from mothers not infected) = 20 *SES level:* median family income *Ethnicity*: 51% afro-descendant (mothers' race) *Source of recruitment*: Births at Tangará da Serra	Cognition, language (expressive and receptive), motor (gross and fine), socioemotional, and adaptive behavior (18 to 29m)	Bayley-III / classification / NI / NI	*Infant's characteristics:* Anthropometric and laboratory criteria for microcephaly / medical records	NS (in both groups normal development)
Machado et al. (2019)	Cross-sectional, case-control study / Between-group comparison and Regression analysis	n = 45 children (55% boys) *Groups:* PT = 23; CG = 22 *SES level:* NI *Ethnicity:* NI *Source of recruitment*: Maternity of the University Hospital	Motor, cognition and sensory processing (12m)	Bayley-III Screening Test / score / Yes / Yes TSFI / score / Yes / No	*Infant's characteristics:* Gestational age, birth weight; gender / medical records	Motor and cognition: PT < CG PT →↓sensory processing ↑ Motor →↑Ocular-motor control

Note: SES = Socioeconomic Status; NS = Non-significant statistically; NI = Not informed; Denver II = Denver II Development Screening Test; NPI = Nasopharyngeal Intubation; NEE = Neurological Evolutionary Examination; CLP = Cleft Lip and Palate; CG = Control Group; MacArthur = MacArthur Communicative Development Inventory; CH = Congenital Hypothyroidism; PPVT-R = Peabody Picture Vocabulary Teste – Revised; SBIS = Stanford-Binet Intelligence Scale; SMM = Severe Maternal Morbidity; ASSIST = Alcohol, Smoking and substance Involvement Screening Test 2.0; PT = Preterm; FT = Full Term; LBW = Low Birth Weight; VLBW = Very Low Birth Weight; CEC = Child Education Center; ZIKV = Zika Virus; TSFI = Test of Sensory Functions in Infants; UtA-PI = Uterine artery pulsatility index; Bayley-III = Bayley Scales of Infant and Toddler Development III; ASQ-3 = Ages and Stages Questionnaire Third Edition; HINE = Hammersmith Infant Neurological Examination; IBGE = Instituto Brasileiro de Geografia e Estatística; USDA = United States Department of Agriculture; HAZ = height-for-age; WAZ = weight-for-age; KM = Kangaroo Method; INTER-NDA = INTERGROWTH-21st Neurodevelopment Assessment; PRIDI = Regional Project on Child Development Indicators; IDELA = International Development and Early Learning Assessment; SWYC = Survey of Wellbeing of Young Children; SGA = Small for Gestational Age.

Table 3. Continued...

Author/ Year	Study design/ Data analysis	Sample	Primary outcomes: Child development domains/ Age of children	Instruments/ Measures/ Translation/ Cultural adaptation (Yes/No/NI)	Predictors, independent variables or secondary outcomes/ Measures	Main Findings (Child Development)
Okido et al. (2020)	Cohort study / Between- and Within-group comparison	n = 964 children (52% girls) *Groups:* UtA-PI ≥ 90 group = children of mothers with UtA-PI ≥ 90 during pregnancy; UtAPI < 90 group = children of mothers with UtAPI < 90 during pregnancy; *SES level:* NI *Ethnicity*: Caucasian = 63.5% and 52% in each group *Source of recruitment*: Health units	Motor, cognition and language (13-35 m)	Bayley-III Screening Test / classification / NI / NI	*Infant's characteristics:* Gender *Maternal factors:* Uterine artery pulsatility index (UtA-PI) / obstetric ultrasonography	Groups: NS (normal development for both) Neurodevelopmental risk: boys > girls
Silva et al. (2017)	Cross-sectional, case-control study / Between group comparison	n = 80 children (50% boys) whose mothers were infected or not during pregnancy *Groups*: EG = 40 HIV+; CG = 40 HIV-; *Group of ages*: 4, 8, 12 and 18m *SES level:* C-level = 80% *Ethnicity*: NI *Source of recruitment*: Referral center of AIDS	Motor and cognition (4, 8, 12, and 18m)	Bayley-III Screening Test / score / NI / NI	*Infant's characteristics:* Age, HIV diagnosis / medical records *Family conditions:* SES level	Motor: CG > EG; 8m and 12m > 4m; 8m > 18m; Cognitive: CG > EG; 4m, 8m and 12m > 18m Group * Age: CG > EG at 8m and 18m, for cognitive CG and EG: cognitive development within or above average
Child development evaluated by ASQ (n = 4 studies)						
Bertolli et al. (2020)	Cross-sectional, descriptive study/ Descriptive	n = 120 children (50% boys) *SES level:* 58% family income (R$) 500-1,499 *Ethnicity*: 68% brown *Source of recruitment*: Infants conceived during the 2015–2016 Zika virus outbreak in northeastern Brazil, from a microcephaly and congenital Zika infection cohort.	Motor, communication, problem solving, and personal–social (19 to 26m)	ASQ-3 / score / NI / NI	*Infant's characteristics:* Anthropometric and laboratory criteria for microcephaly / medical records Neuromotor function, visual and auditory responses / HINE	Developmental delay (with both anthropometric and laboratory measures): 63% severe, 16% mild-moderate; 23% no developmental delay

Note: SES = Socioeconomic Status; NS = Non-significant statistically; NI = Not informed; Denver II = Denver II Development Screening Test; NPI = Nasopharyngeal Intubation; NEE = Neurological Evolutionary Examination; CLP = Cleft Lip and Palate; CG = Control Group; MacArthur = MacArthur Communicative Development Inventory; CH = Congenital Hypothyroidism; PPVT-R = Peabody Picture Vocabulary Teste – Revised; SBIS = Stanford-Binet Intelligence Scale; SMM = Severe Maternal Morbidity; ASSIST = Alcohol, Smoking and substance Involvement Screening Test 2.0; PT = Preterm; FT = Full Term; LBW = Low Birth Weight; VLBW = Very Low Birth Weight; CEC = Child Education Center; ZIKV = Zika Virus; TSFI = Test of Sensory Functions in Infants; UtA-PI = Uterine artery pulsatility index; Bayley-III = Bayley Scales of Infant and Toddler Development III; ASQ-3 = Ages and Stages Questionnaire Third Edition; HINE = Hammersmith Infant Neurological Examination; IBGE = Instituto Brasileiro de Geografia e Estatística; USDA = United States Department of Agriculture; HAZ = height-for-age; WAZ = weight-for-age; KM = Kangaroo Method; INTER-NDA = INTERGROWTH-21st Neurodevelopment Assessment; PRIDI = Regional Project on Child Development Indicators; IDELA = International Development and Early Learning Assessment; SWYC = Survey of Wellbeing of Young Children; SGA = Small for Gestational Age.

Table 3. Continued...

Author/ Year	Study design/ Data analysis	Sample	Primary outcomes: Child development domains/ Age of children	Instruments/ Measures/ Translation/ Cultural adaptation (Yes/No/NI)	Predictors, independent variables or secondary outcomes/ Measures	Main Findings (Child Development)
Correia et al. (2019)	Cross-sectional study (nested in a cohort) / Between-group comparison	n = 3,566 children (50% boys) *SES level:* 78% lowest socioeconomic class; 61% conditional cash transfer programs *Ethnicity*: NI *Source of recruitment*: Research of Maternal Infant Health	Motor (fine, gross), problem-solving, communication, and personal-social (0 to 6y)	ASQ-3 / score / Yes / Yes	*Infant's characteristics:* Gender, age / questionnaire *Family conditions:* social class, food insecurity, monthly income, cash transfer / questionnaire, IBGE, USDA questionnaire	Developmental delay in all domains: 36-72 > 36 m Risk for communication, gross motor and personal-social development delays: boys > girls At least one domain with developmental delay (overall): boys > girls ↑ Monthly income → ↓ risk of development delay in communication, gross and fine motor ↑ Overall social class→ ↓ risk of developmental delay in gross and fine motor ↑ Food insecurity→ ↑ communication delay Conditional cash transfer participants *vs.* no participants: NS In the conditional cash transfer participants → ↓ risk of development delay in gross motor, communication, and personal-social
Fink et al. (2018)	Cross-sectional study (nested in a cohort) / Regression analysis	n = 900 infants (55% girls) *SES level:* NI ; Educational level: 41% secondary education. *Ethnicity*: NI *Source of recruitment*: Birth cohort, University Hospital	Neuropsychological development: fine motor, problem-solving, communication, gross motor, and personal-social (12m)	ASQ-3 / classification / Yes / Yes	*Infant's characteristics:* Gestational age / INTERGROWTH fetal growth standards Gender	Preterm birth → ↓neuropsychological development SGA → ↓HAZ and ↓WAZ SGA → ↓ neuropsychological development, for boys
Fonseca Filho et al. (2021)	Longitudinal study / Between-group comparison	n = 35 infants PT, LBW and KM (70% boys) *SES level:* Family income = 1396.33 reais (±938.61) *Ethnicity*: NI *Source of recruitment*: premature newborns hospitalized at University Maternity Hospital	Motor, communication, personal-social, problem solving (12m)	ASQ-3 / score / NI / NI	*Infant's characteristics:* Gender, cardiac structure and function / medical records	Intraventricular hemorrhage grade 1 (structure) (newborn) → ↓ personal/social (12m) Fine motor, problem solving, and personal-social, at 12m: boys < girls
Child development evaluated by other *scales* (n = 3 studies)						

Note: SES = Socioeconomic Status; NS = Non-significant statistically; NI = Not informed; Denver II = Denver II Development Screening Test; NPI = Nasopharyngeal Intubation; NEE = Neurological Evolutionary Examination; CLP = Cleft Lip and Palate; CG = Control Group; MacArthur = MacArthur Communicative Development Inventory; CH = Congenital Hypothyroidism; PPVT-R = Peabody Picture Vocabulary Teste – Revised; SBIS = Stanford-Binet Intelligence Scale; SMM = Severe Maternal Morbidity; ASSIST = Alcohol, Smoking and substance Involvement Screening Test 2.0; PT = Preterm; FT = Full Term; LBW = Low Birth Weight; VLBW = Very Low Birth Weight; CEC = Child Education Center; ZIKV = Zika Virus; TSFI = Test of Sensory Functions in Infants; UtA-PI = Uterine artery pulsatility index; Bayley-III = Bayley Scales of Infant and Toddler Development III; ASQ-3 = Ages and Stages Questionnaire Third Edition; HINE = Hammersmith Infant Neurological Examination; IBGE = Instituto Brasileiro de Geografia e Estatística; USDA = United States Department of Agriculture; HAZ = height-for-age; WAZ = weight-for-age; KM = Kangaroo Method; INTER-NDA = INTERGROWTH-21st Neurodevelopment Assessment; PRIDI = Regional Project on Child Development Indicators; IDELA = International Development and Early Learning Assessment; SWYC = Survey of Wellbeing of Young Children; SGA = Small for Gestational Age.

Table 3. Continued...

Author/ Year	Study design/ Data analysis	Sample	Primary outcomes: Child development domains/ Age of children	Instruments/ Measures/ Translation/ Cultural adaptation (Yes/No/NI)	Predictors, independent variables or secondary outcomes/ Measures	Main Findings (Child Development)
Neves et al. (2020)	Cross-sectional study (nested in a cohort) / Between group comparison and Regression analysis	n = 3,776 infants (51% boys)	Motor, language and cognitive (24m)	INTER-NDA / scores / NI / NI	*Maternal factors:* Pre-pregnancy nutritional status, body mass index (BMI), gestational weight gain (GWG)/ Prenatal register cards and maternal report	Language and cognitive: girls < boys
Raess et al. (2022)		*SES level:* Family income 20% for each quintile *Ethnicity* (Maternal skin color): White = 70.6%; Black = 13.1%; Brown or others = 16.1% *Source of recruitment*: Pelotas Birth Cohort			*Infant's characteristics:* Gender / Maternal report	↓Number of antenatal care visits, birth weight and prematurity → ↑Suspected developmental delay, in boys ↓Maternal schooling, family income, maternal occupation and parity, number of antenatal care visits, birth weight, and prematurity → ↑Suspected developmental delay, in girls Insufficient gestational weight gain →↓motor delay, in all sample Excessive gestational weight gain →↑Suspected delay in language and cognitive, in boys Pre-pregnancy underweight →↑ delay in global, language, and motor, in girls

Note: SES = Socioeconomic Status; NS = Non-significant statistically; NI = Not informed; Denver II = Denver II Development Screening Test; NPI = Nasopharyngeal Intubation; NEE = Neurological Evolutionary Examination; CLP = Cleft Lip and Palate; CG = Control Group; MacArthur = MacArthur Communicative Development Inventory; CH = Congenital Hypothyroidism; PPVT-R = Peabody Picture Vocabulary Teste – Revised; SBIS = Stanford-Binet Intelligence Scale; SMM = Severe Maternal Morbidity; ASSIST = Alcohol, Smoking and substance Involvement Screening Test 2.0; PT = Preterm; FT = Full Term; LBW = Low Birth Weight; VLBW = Very Low Birth Weight; CEC = Child Education Center; ZIKV = Zika Virus; TSFI = Test of Sensory Functions in Infants; UtA-PI = Uterine artery pulsatility index; Bayley-III = Bayley Scales of Infant and Toddler Development III; ASQ-3 = Ages and Stages Questionnaire Third Edition; HINE = Hammersmith Infant Neurological Examination; IBGE = Instituto Brasileiro de Geografia e Estatística; USDA = United States Department of Agriculture; HAZ = height-for-age; WAZ = weight-for-age; KM = Kangaroo Method; INTER-NDA = INTERGROWTH-21st Neurodevelopment Assessment; PRIDI = Regional Project on Child Development Indicators; IDELA = International Development and Early Learning Assessment; SWYC = Survey of Wellbeing of Young Children; SGA = Small for Gestational Age.

Table 3. Continued...

Author/ Year	Study design/ Data analysis	Sample	Primary outcomes: Child development domains/ Age of children	Instruments/ Measures/ Translation/ Cultural adaptation (Yes/No/NI)	Predictors, independent variables or secondary outcomes/ Measures	Main Findings (Child Development)
Raess et al. (2022)	Cohort study / Between group Comparison and Regression Analysis	n = 3385 children (51% girls)	Cognition, language, socio-emotional, motor and behavioral outcomes (Timepoint 1: 3y and Timepoint 2: 6y)	PRIDI / score / NI / NI	*Infant's characteristics:* age, gender, birthweight at birth, prematurity, small for gestational age, APGAR, disability status / medical records,	↑Noise exposure → ↑emotional, conduct and peer relationship problems, at 3y
		SES level: 73% B1 or < *Ethnicity:* 60% white mothers *Source of recruitment:* Birth cohort, University Hospital		IDELA / score / NI / NI	Exposure to stimulating activities / HOME	↑Noise exposure → ↑social, internalizing, attention, and anxiety/depression problems
					Family conditions: Socioeconomic level	Community noise exposure and cognitive development at 3y and 6y: NS
					Maternal health: Depression / Edinburgh scale	
Silva et al. (2020)	Cross-sectional, case-control study (nested in a cohort) / Between-group comparison analysis	n= 274 children (54% girls)	Cognition, language, motor, milestones, emotional, and behavioral symptoms (10 to 45 m)	SWYC / scores and classification / Yes	*Infant's characteristics:* HC for sex and age, neurological development / medical records	Frequency of abnormal neurological findings: Group 1 > others; neuroradiological alterations: Group 1 > others
		Groups: Group 1 (Severe Microcephaly) = 114; Group 2 (Moderate microcephaly) = 20; Group 3 (Normocefalic children of ZIKV maternal infection) = 94; Group 4 (Control group) = 46				Risks for developmental delay: Group 1 = 99% ; Group 2 = 65% ; Groups 3 and 4 = similar frequencies of children at risk of development delay
		SES level: NI *Ethnicity*: NI *Source of recruitment*: MERG Pediatric cohort, tertiary care hospitals				Developmental delay: at risk microcephalic > at risk normocephalic

Note: SES = Socioeconomic Status; NS = Non-significant statistically; NI = Not informed; Denver II = Denver II Development Screening Test; NPI = Nasopharyngeal Intubation; NEE = Neurological Evolutionary Examination; CLP = Cleft Lip and Palate; CG = Control Group; MacArthur = MacArthur Communicative Development Inventory; CH = Congenital Hypothyroidism; PPVT-R = Peabody Picture Vocabulary Teste – Revised; SBIS = Stanford-Binet Intelligence Scale; SMM = Severe Maternal Morbidity; ASSIST = Alcohol, Smoking and substance Involvement Screening Test 2.0; PT = Preterm; FT = Full Term; LBW = Low Birth Weight; VLBW = Very Low Birth Weight; CEC = Child Education Center; ZIKV = Zika Virus; TSFI = Test of Sensory Functions in Infants; UtA-PI = Uterine artery pulsatility index; Bayley-III = Bayley Scales of Infant and Toddler Development III; ASQ-3 = Ages and Stages Questionnaire Third Edition; HINE = Hammersmith Infant Neurological Examination; IBGE = Instituto Brasileiro de Geografia e Estatística; USDA = United States Department of Agriculture; HAZ = height-for-age; WAZ = weight-for-age; KM = Kangaroo Method; INTER-NDA = INTERGROWTH-21st Neurodevelopment Assessment; PRIDI = Regional Project on Child Development Indicators; IDELA = International Development and Early Learning Assessment; SWYC = Survey of Wellbeing of Young Children; SGA = Small for Gestational Age.

Table 4. Summary of the main findings of the studies about child development assessment in Latin-American countries (n = 9).

Author/ Year/ Country	Study design/ Data analysis	Sample	Primary outcomes: child development domains/ Age of children	Instruments/ Measures/ Translation/ Cultural adaptation (Yes/No/NI)	Predictors, independent variables or secondary outcomes/ Measures	Main Findings (Child development)
Child development evaluated by EAD (n = 3)						
Lerma Castaño et al. (2019) / Colombia	Cross-sectional study / Correlation analysis	n = 240 children (50% boys) *Ethnicity*: NI *Source of recruitment*: Child Development Centers in Neiva, Huila	Gross motor (1 to 5y)	EAD-3 / classification / NI / NI	*Maternal factor:* Perinatal risks / *Cuestionario Materno de Riesgo Perinatal*	85.4% expected development; 10.8% at risk; 3.8% suspicion of problems ↓ Gross motor: ↑ month of the first pregnancy visit; smoking during pregnancy; diseases during pregnancy; signs of abortion; consumption of medications during pregnancy; consumption of psychoactive substances; constant falls; child hospitalizations ↑ Gross motor: ↑ gestation time; important health conditions; special care after delivery
Lerma Castaño et al. (2020) / Colombia	Cross-sectional study/ Correlation analysis	n = 240 children (gender NI) *SES level:* stratum I and II *Ethnicity*: NI *Source of recruitment*: two Child Development Centers in Neiva, Huila	Fine motor (2 to 5y)	EAD-3 / classification / NI / NI	*Maternal factor:* Psychoactive substance consumption, Pregnancy abortion signs / Questionnaire *Infant's characteristics:* gestational age, delivery time, birth weight, birth type / Medical records	↓ Fine Motor: ↑ Psychoactive substance consumption; pregnancy abortion signs ↑ Fine Motor: ↑ gestational age; delivery time; birth weight
Pacheco et al. (2021) / Colombia	Cross-sectional study / Correlation analysis	n = 60 children (55% boys) *SES level:* NI *Ethnicity*: 98% mestizo *Source of recruitment*: children reported to *Instituto Nacional de Salud* with symptoms of ZIKV infection	Neurodevelopment (20 to 30m)	EAD-1 / scores / Yes / Yes	*Infant's characteristics:* Hearing, eye, or neurologic findings, growth percentiles / Medical examination	12.8% hearing-language domain alert ↑ Age at symptom: ↑ personal-social Gross and fine motor and hearing-language: NS

Note: SES = Socioeconomic Status; NS = Non-significant statistically; NI = Not informed; EAD-3 = Escala Abreviada de Desarrollo Third Edition; EAD-1 = Escala Abreviada de Desarrollo First Edition; SRQ-20 = Self Reporting Questionnaire 20 items; CG = Control Group; PPVT = Peabody Picture Vocabulary Teste; W&S = Water and Sanitation; HIV = Human Immunodeficiency Virus; ASQ-3 = Ages and Stages Questionnaire Third Edition; HSC = Hopkins Symptom Checklist; GSS = Global Stress Score; DUNCSS = Duke University of North Carolina Social Support; HOME = Home Observation for Measurement of the Environment; Denver II = Denver II Development Screening Test; Bayley-III = Bayley Scales of Infant and Toddler Development III; WPPSI = Wechsler Preschool and Primary Scale of Intelligence; ZIKV = Zika Virus; IDELA = International Development and Early Learning Assessment; EEDP = Escala de Evaluación del Desarrollo Psicomotor; EAIS = Escala Argentina de Inteligencia Sensoriomotriz.

Table 4. Continued...

Author/ Year/ Country	Study design/ Data analysis	Sample	Primary outcomes: child development domains/ Age of children	Instruments/ Measures/ Translation/ Cultural adaptation (Yes/No/NI)	Predictors, independent variables or secondary outcomes/ Measures	Main Findings (Child development)
Child development evaluated by PPVT (n = 2)						
Bendini & Dinarte (2020) / Peru	Longitudinal study/ SEM	n = 1,095 children (50% boys) *SES level:* NI; *Caregiver's schooling*: 79% literate, 57% not completed primary school; *Caregiver's health:* 30% mental health issues *Ethnicity*: 16% indigenous *Source of recruitment*: Young Lives Peru Survey Development	Early vocabulary (Timepoint 1: 6 to 20m [mean = 12m] and Timepoint 2: 4 to 6y [mean = 5y])	PPVT / scores / No / No	*Maternal factor:* Mental health / SRQ-20 *Family conditions:* External shocks (e, g., natural disaster, crop or livestock loss, decrease in food availability, job or income loss, death or severe illness, and birth/ new household member), wealth, housing quality, nutritional status and consumption of durable goods / Questionnaire	↑ Nutritional status → ↑ vocabulary, all sample Mothers living with heavy-drinking partners → ↓ vocabulary, all sample ↑ Maternal depression (during and post pregnancy) → ↓ vocabulary at 5y ↑ Maternal depression * household wealth → ↓ vocabulary at 5y (for less wealthy households) Negative shocks * low-income for pregnant woman → ↓ vocabulary (12m) ↑ Maternal mental health problems (at 12m) → ↓ vocabulary at 5y Vocabulary: Maternal mental health problems living with partner * shock effect > Maternal mental health problems living without partner * shock effect; Vocabulary: urban > rural area
Dearden et al. (2017) / Peru	Longitudinal study/ Regression Analysis	n = 1,852 children (51% boys) *SES level:* NI; Mother's completed schooling: 7,8% *Ethnicity*: NI *Source of recruitment*: Young Lives Younger Cohort of children in Ethiopia, India, Peru and Vietnam	Receptive vocabulary (5y)	PPVT / scores / Yes / Yes	*Infant's characteristics:* Gender, age / questionnaire *Community conditions:* Improved W&S, area of residence, community population, wealth and services / Household access to improved W&S *Family conditions:* Mother's age and height, parents' schooling / questionnaire	↑ Improved toilets (1y) → ↑ receptive vocabulary (5y) (*adjusted for child, household, parent, and community variables*) ↑ Improved toilets (5y) → ↑ receptive vocabulary (5y) (*adjusted for child, household, and parent variables*) Improved water (1 and 5y) and receptive vocabulary: NS

Note: SES = Socioeconomic Status; NS = Non-significant statistically; NI = Not informed; EAD-3 = Escala Abreviada de Desarrollo Third Edition; EAD-1 = Escala Abreviada de Desarrollo First Edition; SRQ-20 = Self Reporting Questionnaire 20 items; CG = Control Group; PPVT = Peabody Picture Vocabulary Teste; W&S = Water and Sanitation; HIV = Human Immunodeficiency Virus; ASQ-3 = Ages and Stages Questionnaire Third Edition; HSC = Hopkins Symptom Checklist; GSS = Global Stress Score; DUNCSS = Duke University of North Carolina Social Support; HOME = Home Observation for Measurement of the Environment; Denver II = Denver II Development Screening Test; Bayley-III = Bayley Scales of Infant and Toddler Development III; WPPSI = Wechsler Preschool and Primary Scale of Intelligence; ZIKV = Zika Virus; IDELA = International Development and Early Learning Assessment; EEDP = Escala de Evaluación del Desarrollo Psicomotor; EAIS = Escala Argentina de Inteligencia Sensoriomotriz.

Table 4. Continued...

Author/ Year/ Country	Study design/ Data analysis	Sample	Primary outcomes: child development domains/ Age of children	Instruments/ Measures/ Translation/ Cultural adaptation (Yes/No/NI)	Predictors, independent variables or secondary outcomes/ Measures	Main Findings (Child development)
Child development evaluated by other scales (n = 4)						
Muñoz et al. (2017) / Peru	Cross-sectional study / Between-group comparison	n = 14 children (gender NI) *Groups*: 7 HIV+; 7 HIV- *SES level:* NI *Ethnicity*: NI *Source of recruitment*: families who received outreach support from *Socios En Salud*	Neurodevelopmental delas (1 to 3y)	ASQ-3 / classification / No / No	*Maternal factor:* Psychosocial status, responsiveness / HSC, GSS, DUNCSS, HOME	71.4% delay in at least one child development domain ↑ Caregivers` depression and stress → ↑ developmental delay  ↑ Mothers` ability to respond and mothers` acceptance → ↑ development
de la Parra et al. (2017) / Chile	Longitudinal study / Between group comparison	n = 70 children (53% boys) *Groups:* A (Very good metabolic control) = 30; B (Good metabolic control) = 20; C (Poor metabolic control) = 20 *SES level:* NI *Ethnicity*: NI *Source of recruitment*: neonatal screening at Laboratory of Genetic and Metabolic Diseases	Psychomotor development (12, 24 and 30m) Intelligence (4y to 6y)	Bayley-II / scores / NI / NI WPPSI / scores / NI / NI	*Infant's characteristics:* Plasma Phe concentrations / blood sample	Development: NS Intelligence: Group A > Group C
Rey-Guerra et al. (2022) / Colômbia	Cross-sectional study / multilevel model	n = 3,069 children (50.5% girls) *Groups:* Home-based (n = NI); Center-based (n = NI) *SES level:* NI *Ethnicity*: NI *Source of recruitment*: National Quality Measurement of Early Childhood Education	Early learning and development (3 to 5y)	IDELA / scores / NI / NI	*Infant's characteristics:* Age, gender *Family conditions:* education attainment, economic status *School aspects:* teacher's highest educational level, teachers' years of experience, type of classroom, pedagogical quality	Home-based family engagement → ↑ emergent numeracy, emergent literacy, social-emotional, motor, and executive functions Center-based family engagement → ↑ numeracy, emergent literacy, social-emotional, and motor development All developmental domains: Home-based family engagement > center-based family engagement

Note: SES = Socioeconomic Status; NS = Non-significant statistically; NI = Not informed; EAD-3 = Escala Abreviada de Desarrollo Third Edition; EAD-1 = Escala Abreviada de Desarrollo First Edition; SRQ-20 = Self Reporting Questionnaire 20 items; CG = Control Group; PPVT = Peabody Picture Vocabulary Teste; W&S = Water and Sanitation; HIV = Human Immunodeficiency Virus; ASQ-3 = Ages and Stages Questionnaire Third Edition; HSC = Hopkins Symptom Checklist; GSS = Global Stress Score; DUNCSS = Duke University of North Carolina Social Support; HOME = Home Observation for Measurement of the Environment; Denver II = Denver II Development Screening Test; Bayley-III = Bayley Scales of Infant and Toddler Development III; WPPSI = Wechsler Preschool and Primary Scale of Intelligence; ZIKV = Zika Virus; IDELA = International Development and Early Learning Assessment; EEDP = Escala de Evaluación del Desarrollo Psicomotor; EAIS = Escala Argentina de Inteligencia Sensoriomotriz.

Table 4. Continued...

Author/ Year/ Country	Study design/ Data analysis	Sample	Primary outcomes: child development domains/ Age of children	Instruments/ Measures/ Translation/ Cultural adaptation (Yes/No/NI)	Predictors, independent variables or secondary outcomes/ Measures	Main Findings (Child development)
Romero et al. (2019) / Argentina	Longitudinal study / Descriptive analysis	n = 102 children (53% girls)	Psychomotor development and sensorimotor intelligence (Timepoint 1: 6 and Timepoint 2: 9 m)	EEDP / classification / NI / Yes	*Family conditions:* Age, education, employment status, obstetric history / Questionnaire	At 6 m: 22.5% developmental risk or delay; 13.7% in psychomotor (EEDP) and 16.7% in sensorimotor intelligence (EAIS).
		SES level: NI Maternal education (incomplete secondary): 64%; Paternal education (incomplete secondary): 69%		EAIS / classification / NI / Yes		At 9 m: 20.6% developmental risk or delay; 14.7% in psychomotor (EEDP) and 9.8% in sensorimotor intelligence (EAIS).
		Ethnicity: NI				
		Source of recruitment: Pediatric health checkup at the Health Observatory of the Pediatric Research and Development Institute				

Note: SES = Socioeconomic Status; NS = Non-significant statistically; NI = Not informed; EAD-3 = Escala Abreviada de Desarrollo Third Edition; EAD-1 = Escala Abreviada de Desarrollo First Edition; SRQ-20 = Self Reporting Questionnaire 20 items; CG = Control Group; PPVT = Peabody Picture Vocabulary Teste; W&S = Water and Sanitation; HIV = Human Immunodeficiency Virus; ASQ-3 = Ages and Stages Questionnaire Third Edition; HSC = Hopkins Symptom Checklist; GSS = Global Stress Score; DUNCSS = Duke University of North Carolina Social Support; HOME = Home Observation for Measurement of the Environment; Denver II = Denver II Development Screening Test; Bayley-III = Bayley Scales of Infant and Toddler Development III; WPPSI = Wechsler Preschool and Primary Scale of Intelligence; ZIKV = Zika Virus; IDELA = International Development and Early Learning Assessment; EEDP = Escala de Evaluación del Desarrollo Psicomotor; EAIS = Escala Argentina de Inteligencia Sensoriomotriz.

Child development in Brazilian studies

First, seven studies used the Denver II screening test for the assessment of child development. Regarding the prenatal characteristics analysis, children aged 6 months to 5 years with severe maternal morbidity and substance abuse during pregnancy (tobacco and cocaine) presented significant developmental delay compared to the control group of children aged from 6 months to 5 years (Pereira et al., 2018). Focusing on neonatal characteristics, from one to three years of age, preterm-born children with low or very low weight performed worse in the motor, language, and personal-social domains than children born full-term (Ribeiro et al., 2017).

In three studies, the target sample presented a specific disease condition. Children with non-syndromic repaired cleft lip and palate (CLP) had a 76.6% risk of developmental delay, predominantly in the language domain (69.5%), compared to the control group of typically developing children aged 36 to 47 months. Specifically, girls with congenital hypothyroidism who had been treated since the neonatal period had significantly lower scores in the fine and gross-motor and language domains of the Denver II compared to those of the typical development group of children aged 38-70 months (Lamônica et al., 2020). Otherwise, no statistically significant differences were found in a sample of 2-to-6-year-old children with isolated Robin sequence (genetic disease) split into children treated exclusively with nasopharyngeal intubation (NPI) and those treated exclusively with postural method groups; both groups presented normal development classification (Alencar et al., 2017).

In two studies, the samples were recruited in an educational setting. In child educational centers, 54% of 0-to-5-year-old children presented developmental delay risks, with higher risks in the personal-social and language domains. Boys, older children, and those attending the center part-time were at greater risk of developmental delay than girls, younger children, and those attending the center full-time (Yamaguchi et al., 2019). Also, in public educational units, girls performed better in the fine motor, language, and personal-social domains and worse in the gross-motor domain compared to boys (Silva et al., 2018).

Bayley scales were applied for child development assessment in five studies with targeted samples for evaluating health conditions. Three studies analyzed prenatal conditions such as human immunodeficiency virus (HIV)-positive mothers (Silva et al., 2017), maternal Zika virus infection (Gerzson et al., 2020), and maternal resistance to uterine artery flow (Okido et al., 2020). Children of mothers diagnosed with HIV during pregnancy showed lower motor and cognitive performance than children of mothers not diagnosed with HIV at all ages (Silva et al., 2017).

Nevertheless, in both studies of mothers' Zika virus infection and increased resistance to uterine artery flow, no effects were found on child development outcomes (Gerzson et al., 2020; Okido et al., 2020). Normocephalic children born to mothers with Zika virus infection during pregnancy presented similar cognitive, language, and motor performances at 18-29 months of age to control group normocephalic children born to mothers without Zika virus infection showing normal development (Gerzson et al., 2020). In addition, a cohort of children of mothers with resistance to uterine artery flow showed similar performance in the cognitive, communication, and motor domains at 13-35 months when considering groups differentiated by the uterine artery pulsatility index (UtA PI ≥ 90 [high-level] and UtA PI < 90 [low-level]) (Okido et al., 2020). However, in this study, boys presented a significantly higher neurodevelopmental risk than girls.

Focusing on neonatal conditions, preterm-born children presented lower performance in the motor and cognitive domains than their full-term counterparts at 12 months of age, and prematurity was associated with low sensory processing; however, improvement in motor development was associated with better ocular-motor control levels (Machado et al., 2019). The CH group presented significantly worse performance in the fine- and gross-motor domains at 1-42 months of age compared to their control counterparts (Frezzato et al., 2017).

Third, the ASQ scale for child development evaluation was used in four studies, three of which focused on health conditions and other on socioeconomic variables. In neonates born preterm with low birth weight under kangaroo care during hospitalization, the intraventricular hemorrhage grade 1 condition was associated with decreased scores in the personal-social domain; girls performed better in the fine motor, problem-solving, and personal-social domains than boys at 38 weeks of post-natal corrected age for prematurity (Fonseca Filho et al., 2021). In addition, preterm boys born small for gestational age had lower neuropsychological development performance at 12 months of age (Fink et al., 2018). Approximately 77% of children with congenital Zika virus infection at 19 to 26 months presented a degree of developmental delay (63% severe and 16% mild to moderate delay), based on both anthropometric and laboratory measures (Bertolli et al., 2020). In a large sample of 3,566 children aged 0-6 years, developmental delay in all domains was higher in children aged 36-72 months than in children under 36 months of age; boys presented at least one domain with developmental delay and higher risk in the communication, gross-motor, and personal-social domains than girls (Correia et al., 2019).

In the last three studies, different instruments were used to evaluate child development. A large study sample of 3,776 children demonstrated that boys performed better in the language and cognitive domains than girls at 24 months of age, as assessed using the INTER-NDA tool. A low number of antenatal care visits, low birth weight, and prematurity were significantly associated with a higher risk of developmental delay in boys. Among girls, low maternal schooling, family income, maternal occupational level and parity, number of antenatal care visits, birth weight, and gestational age were associated with a higher risk of developmental delay (Neves et al., 2020).

One study used the SWYC scale to evaluate the development of children with severe and moderate Zika virus-related microcephaly and children with prenatal Zika virus exposure in the absence of microcephaly (Silva et al., 2020). The findings of this study showed that children with severe microcephaly presented a 99% of risk for developmental delay, while moderate microcephaly children had a 65% of prevalence at 10-45 months old. Children with prenatal Zika virus exposure in the absence of microcephaly showed similar results to those in the control group (neurotypical).

A longitudinal cohort study evaluated 3,385 children to examine the effects of community noise exposure on cognitive and behavioral development at 3 and 6 years of age (Raess et al., 2022). It is important to note that cognitive development was not significantly associated with community noise exposure at 3 years of age, as assessed by the PRIDI, and 6 years of age, as evaluated using the IDELA tool. However, higher noise levels were associated with increasing borderline or clinical difficulties of behavior (assessed using SDQ scale) in children at 3 years of age, predominantly in emotional problems, followed by conduct problems and peer relationship difficulties.

Regarding the psychometric qualities of the instruments used in the 19 Brazilian studies, the great majority of them did not inform about translations and cultural adaptation of the tools (n=13; 68%). Focusing on the remaining nine studies, two ones reported that they did not use the cultural adaptation of Denver-II, in which only one study used a free-translation. One study used the Bayley screening with cultural adaptation, and TSFI translated. Two studies applied the ASQ-3 with cultural adaptation. Finally, only one study used the SWYC validated to Brazilian population.

Child development in Colombian studies

Four studies on child development assessment were conducted in Colombia, of which three used the EAD scale. Two studies analyzed the same sample of children using the EAD tool (Lerma Castaño et al., 2019, 2020). First, 85.4% of 240 children aged 1-5 years presented normal development, while 10.8% were at risk of development problems and 3.8% were suspected of having problems. Additionally, this study found that late first pregnancy visit, smoking during pregnancy, diseases during pregnancy, signs of abortion, medication use during pregnancy, consumption of psychoactive substances, repeated falls, child hospitalizations were negatively correlated with later gross-motor performance (Lerma Castaño et al., 2019). Second, in the same sample of children assessed at 2-5 years, psychoactive substance consumption and pregnancy abortion signs among mothers were associated with delayed fine-motor skills at the preschool age, while positive correlations were found between adequate gestational age, delivery time, and birth weight and the fine motor domain (Lerma Castaño et al., 2020).

During early childhood development, among children who had suffered from post-natal infection with Zika virus between one and 12 months of age, 12.8% reported hearing-language issues, assessed by the EAD scale, at 20 to 30 months of age (Pacheco et al., 2021). Finally, a large sample of 3,069 children aged 3-5 years old was assessed using the IDELA scale, from which it was determined that home-based family engagement was associated with high levels of emergent numeracy and literacy and social-emotional, motor, and executive functions (Rey-Guerra et al., 2022). Concerning the psychometric qualities of the instruments used in the four Colombian studies, only one of them reported the cultural adaptation of EAD-1. The remaining three studies did not inform about any psychometric aspects.

Child development in Peruvian studies

Three studies conducted in Peru used different tools to assess child development. A study with a small sample of 14 children aged 1-3 years examined neurodevelopment among HIV infected and non-infected children using the ASQ scale. This study showed that 71.4% of the infants presented delays in at least one child development domain, and higher levels of caregivers' depression and stress predicted developmental delays. Notably, mothers' responsiveness and acceptance to children were associated with better child development (Muñoz et al., 2017).

Two studies with large sample sizes assessed child vocabulary outcomes. First, a longitudinal study with a sample of 1,095 children showed that for the entire sample, at 1 and 5 years of age, better child nutritional status was associated with high vocabulary scores on the PPVT scale. However, children whose mothers lived with heavy drinking partners were found to have poor knowledge of vocabulary. Maternal depression during pregnancy or perinatal period, independently, or in combination with less household wealth, was related to possessing poor knowledge of vocabulary at 5 years of age (Bendini & Dinarte, 2020). Second, another longitudinal study assessed vocabulary development using the PPVT scale in a large sample of 1,852 children aged five years old (Dearden et al., 2017). In this study, improvements in toilets when children were one or five years of age predicted better results in vocabulary development (adjusted for child, household, parent, and community variables).

Focusing the psychometric qualities of the instruments used in the three Peruvian studies, two of them used the PPVT tool, in which only one study used the cultural adaptation. One study applied the ASQ-3 without cultural adaptation.

Child development in Chilean studies

A case-control study showed that in groups of children divided into three groups according to the metabolic control (very good, good, and poor levels) measures in the first 12 months of age, there was no significant difference between groups in child development performance, assessed by the Bayley-II, at 12, 24, and 30 months of age. However, children with very good control performed better on the intelligence WPPSI scale than children with good control levels (de la Parra et al., 2017). There was no information about the psychometric quality of the tool used in this study.

Child development in Argentinian studies

A single longitudinal descriptive study was conducted in Argentina, the results of which found a 22.5% of developmental risk or delay in 6-month-old children; specifically, a 13.7% delay in the psychomotor domain (measured by the EEDP tool) and a 16.7% delay in sensorimotor intelligence (measured by the EAIS tool). Additionally, at 9 months of age, children showed a 20.6% developmental risk or delay score; specifically, 14.7% in the psychomotor domain and 9.8% in sensorimotor intelligence (Romero et al., 2019). Both instruments used in this study had cultural adaptations.

Discussion

To date, as far as we know, the present systematic review is the first study that aimed to identify screening, surveillance, or diagnostic tools to assess development profiles of 0-to-6-year-old children, exclusively focusing on LACs. After applying the inclusion and exclusion criteria in the database search, 28 empirical studies from five countries (Brazil, Peru, Colombia, Argentina, and Chile) were reviewed. Most of them (68%) were concentrated in Brazil, indicating the scarcity of child development assessment studies in other LACs. These studies had predominantly the main purposes to examine the effects of child health conditions on early development (e.g., genetic disease, prematurity, low birthweight, microcephaly, Zika virus or HIV infection, cleft lip and palate, hypothyroidism). Also, the objectives were related to examine the associations between child development and maternal health conditions (e.g., severe morbidity, uterine artery flow during pregnancy, substance abuse) or contextual conditions (e.g., external shocks and improved water and sanitation). In general, these several health problems negatively impacted early childhood development at early ages.

Regarding a general overview of the instruments for early child development assessments, in all LAC studies, there were limitations in the psychometric characteristics of the tools used to evaluate child development, specifically in the core components of validity, reliability, and cultural adaptability. In addition, the psychometric properties reported in the studies were diverse, and the reasons for the choice of evaluation tools were not clearly stated by the authors. These findings of the current review were consistent with a previous one that reviewed studies of assessments of children's cognitive development and their learning environments in LMICs (Munoz-Chereau et al., 2021).

In the present review, most of the studies used translations of the original version of the instruments to reflect the natural language of the countries where they were applied. It is important to note that the exclusive use of translation of the instruments for child development assessments is not sufficient and psychometrically adequate, especially when we need to use the cut-off score to detect developmental risks and delays in global or specific domain performances. To address this issue, the linguistic equivalence of the translation in a specific idiom and back translation to the original idiom of a valid and reliable instrument are recommended. However, this process of translation/back translation should be associated with cultural equivalence appropriateness for a particular culture (e.g., an item mentioning snow is not appropriate for the reality of a child living in a tropical country). Investigators in LACs should clearly report the cultural adaptations and the norm-reference of the instruments used in their studies and develop studies with these main purposes to assure the quality and robustness of the findings for their own specific populations.

Focusing on a specific overview of the instruments, among the 28 employed in the reviewed LAC studies, 15 different types of instruments were used for child development assessment. In the evaluation of child development, language and motor function were the predominant domains. However, we detected some incomplete comments regarding the instruments used in the reviewed reports. For this reason, we decided to analyze several of the instrument markers (type of the instrument, developmental domains, translation, cultural adaptation, and cost) to better understand which qualities are to be used by practitioners and researchers in LACs.

The most commonly used tools in the reviewed LAC studies were the Denver II (direct test of observation combined with a caregiver report (Frakenburg et al., 2013)) and Bayley scales (direct test of observation), which are well-recommended instruments for early child development assessments (see Fernald et al., 2009). The Denver II is a low-cost and easy-to-use instrument for screening developmental risks of children aged 0-6, comprises four domains (fine motor, gross motor, language, and personal-social), and uses a binary category for the outcome (risk vs. non-risk) (Frankenburg et al., 1992). The results of our review of LAC studies were consistent with a previous review by Albuquerque & Cunha (2020), which showed that the Denver II was the most commonly used instrument for child development screening in Brazil.

The Bayley scales, in turn, constitute the diagnostic tool considered the "gold standard" for diagnosing early-age developmental delay in the psychomotor, cognitive, and socio-emotional domains (Walder et al., 2012; Fernald et al., 2009; Fernald et al., 2017). However, the Bayley scales are expensive for LACs context, requiring training and licensing for high-profile professionals, as well as time-consuming sessions. These requirements could be barriers to recommending the use of Bayley scales broadly in public assistance systems targeting child development evaluation beyond research or individual clinical purposes. The Bayley scales were created in a developed country with norm-reference for North American sample (Bayley, 2006; Fernald et al., 2009). Moreover, in the present review, the LAC studies did not present cultural validation and standardization of the Bayley III, except for one Brazilian study (Machado et al., 2019), which mentioned the cultural adaptation performed by Madaschi et al. (2016). In this study, the Bayley III was applied to a sample of 207 Brazilian children aged 12-42 months and showed goodness-of-fit indices in confirmatory factor analysis, good internal consistency, and stability for the fine motor scale exclusively. Further psychometric studies are required with population-based samples to better determine the cut-off scores to detect delayed classifications. Thus, the findings of child developmental delay detected by the Bayley in the LAC studies should be interpreted with caution, considering that the cut-off score was standardized for North American population.

Few studies have used the ASQ-3, which is also a well-recommended tool for child development assessment (Fernald et al., 2009). The ASQ-3 is a parent report questionnaire for screening child development problems in the first five years of life (Squires & Bricker, 2009). Its benefits are that is a low-cost tool with 30 items focusing on five domains of child development (gross motor, fine motor, problem-solving, communication, and personal-social) and can be answered easily in the home setting, usually within 12-18 minutes (Lamsal et al., 2018). The ASQ-3 is a Portuguese version that assesses child development in daycare centers in Brazil based on teacher reports (Filgueiras et al., 2013), but this version has not yet been commercialized.

Nevertheless, the ASQ-3 has been used in Brazilian studies, as seen in the present review and the previous study by Albuquerque and Cunha (2020). In Peru, the ASQ-3 cultural adaptation/standardization was adapted and validated for rural populations (Caridad-Araujo et al., 2019; Tarazona Cervantes & Campos Sanchez, 2014). More recently, it has been revised to suit urban populations (Gudiel-Hermoza et al., 2021).

In addition, only one Brazilian study used the SWYC, which is a screening tool to detect child developmental and behavioral problems in children until 5 years and 5 months of age, as well as familial risks (Perrin et al., 2016). The SWYC, which has been validated and culturally adapted for the Brazilian context (Moreira et al., 2019), is a relevant tool option considering its good psychometric qualities with sensitivity for screening risks of early developmental delay. Children 1-24 months of age from low-income families in a municipality of the Brazilian semi-arid region were assessed in terms of psychomotor and social-emotional development and, based on the SWYC scale, were detected to be at particular risk of delay in the social-emotional domain (Sousa et al., 2021).

In the Argentinian study, child development was assessed by the EEDP and EAIs, which are Chilean (Rodriguez et al., 1992) and Argentinian (Oiberman et al., 2006) scales, respectively. On the one hand, there is a value in having their own version of the test with proven validity, norms, and standards for typical development in a specific country, as pointed by Fernald et al. (2009). On the other hand, it creates difficulties when comparing the results of the studies that use their own instruments with studies from other countries.

Considering the methodological aspects of the studies in the present review, first, they presented great variability in the number of participants (14 to 3,776) with a mean of 779. In addition, the representation of children's diversity characteristics (e.g., gender and race) was not detected regularly. The main variable used in the diversity of the samples was gender, with balanced samples of boys and girls; only one study was exclusively composed of girls (Lamônica et al., 2020). The socioeconomic level of the sample, which is a relevant variable, was rarely mentioned in the studies, appearing clearly in less than half of them. Race and ethnic characteristics were not clearly described in the samples, and only one study included an indigenous population (Bendini & Dinarte, 2020). As recommended by Tajima (2021), the diversity of the population should be precisely described in the samples – comprising gender, race, ethnicity, and socioeconomic level – and, if possible, be desegregated in subsamples in the data analysis.

Second, most designs were cross-sectional and case-control than longitudinal and cohort studies. We detected low methodological quality in a significant number of papers, with only seven obtaining a STROBE score of ≥ 75. Thus, generalization of findings should be considered with caution due to the low representativeness of the samples. LAC studies should improve the study design, data analysis, and reports to achieve more robust methodological aspects and valid results.

The following limitations should be noted and considered when interpreting the findings of the present review. First, the review study was determined by selecting certain keywords, inclusion and exclusion criteria, and specific period, all of which could potentially have excluded some articles of interest. Second, the reviewed studies did not systematically report the psychometric properties of the instruments, such as cultural adaptation and standardization with population norm references, which impacts the synthesis of results. Third, there was a concentration of studies on child development in one specific country (Brazil), with very little information about children with other LACs. Fourth, the findings were obtained predominantly using non-culturally adapted instruments, then the developmental delay should be considered with caution. Finally, most papers presented medium methodological quality, which could impact the quality of the reported results.

Future studies in LACs need to be expanded to other countries; specifically, multicenter and multicultural studies are recommended. In addition, future studies should improve the psychometric qualities, especially cultural equivalence and standardization for the population base, of relevant instruments (e.g., the Denver II and Bayley scales) for child development assessments in LAC populations. Investments in longitudinal study designs could contribute to a better evaluation of child development at key ages of their growth trajectory.

The risk and protective factors of early child development can be analyzed using moderation and mediation analyses. Biological and psychosocial risks, such as multiple and cumulative risks, are also relevant factors to be included in the analysis to examine their effects on child development assessments. Population diversity is an emergent demand in studies of child development that needs to be adequately addressed through sample composition, data analysis, data interpretation, and/or discussion of the findings. In future studies, multiple informants in the rating and reports of child development evaluation are relevant aspects to consider, especially the combination of main family caregivers and teachers.

Conclusion

In conclusion, few studies in the present review used instruments with adequate cultural adaptations. As a result, researchers seeking to assess child development in LACs face some challenges in selecting adequate instruments with good psychometric qualities, especially cultural adaptation and standardization for the specific population of interest. The purpose of the assessment, the children's characteristics, and the psychometric properties of the instrument are relevant for choosing an adequate assessment tool (King & Glascoe, 2003; Marks & LaRosa, 2012). To track risks and delays in child development, instruments with good psychometric qualities (e.g., validity, cultural adaptation, feasibility, and standardization) are needed to obtain confident results. *Why, what, and how* to measure children's development at different ages are crucial decisions when selecting suitable early child development measures (Fernald et al., 2009). Thus, we recommend LAC investigators invest in improving methodological care (e.g., study design, representativeness, and the diversity of sample) and choose instruments with appropriate psychometric qualities, which can contribute to more reliable findings of child development at different ages. This investment is essential when we consider the evaluation of the impact of early childhood development programs on the public system at large scale.

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Conflict of interest

None.

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