

Risk Categories in Early Childhood Development and Corresponding Identification Tools: A Narrative Review

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Abstract: This review provides a narrative synthesis of major risk categories and corresponding identification tools in early childhood development (ECD), covering five key categories: impaired health and physiological function, nutritional and physical development deviations, insufficient responsive care, limited access to early learning opportunities, and safety and environmental instability. These risks arise from interconnected mechanisms: impaired health disrupts biological systems; nutritional and physical deviations hinder growth and neurodevelopment; insufficient responsive care weakens social-emotional development; limited early learning constrains cognition and language; and safety and environmental instability affect developmental trajectories through chronic stress pathways. The review further summarizes widely used national and international assessment tools, including health and neurodevelopmental screening instruments, nutritional assessment methods, caregiver-child interaction measures, learning environment evaluation tools, and comprehensive ECD monitoring instruments. Their applications, strengths, and limitations are discussed in detail. Future directions include developing dynamic, multidimensional, and cross-culturally valid assessment frameworks, enhancing the cultural adaptation of existing tools, and strengthening the integration of assessment with policy action and targeted interventions. Establishing a scientific, systematic, and equitable ECD risk identification system will provide essential support for precision intervention, evidence-based policy-making, and the promotion of holistic development for all children.

Keywords: Early childhood development; Risk assessment; Review

1 Introduction

Early Childhood Development (ECD) generally refers to the integrated developmental process from the prenatal period to approximately eight years of age, encompassing multiple domains, including physical growth, motor skills, language, cognition, and social-emotional functioning (World Health Organization, 2023). Its influence not only shapes childhood outcomes but also extends into adulthood, affecting educational attainment, economic capacity, and social productivity (Schoon, Nasim, & Cook, 2021). A substantial body of research has demonstrated that developmental conditions within the first 1,000 days exert profound and lasting effects on brain structure, neural networks, and cognitive functioning (Suri, Verlato, & Ray, 2025; Tooley et al., 2024). Based on this understanding, the assessment, monitoring, and intervention of child development have become major public health priorities worldwide (Ahun, Aboud, Wamboldt, & Yousafzai, 2023).

The Nurturing Care Framework proposed by the World Health Organization emphasizes that optimal child development depends on five core components: good health, adequate nutrition, responsive caregiving, opportunities for early learning, and safety and security (World Health Organization, 2023). This framework has provided essential guidance for countries in formulating child development policies (Tello et al., 2024). However, when these foundational domains are compromised or insufficient, children may be exposed to distinct developmental risks across multiple dimensions (McLaughlin, Sheridan, & Lambert, 2014). Systematic identification and classification of these risk categories are therefore critical for early detection, targeted intervention, and effective policy implementation. Importantly, meaningful risk identification requires reliable and theoretically grounded measurement tools to operationalize and detect these risks in diverse contexts. With continued advances in early childhood development research, the global demand

for developmental measurement tools has steadily increased. The selection and interpretation of these tools must be grounded in a robust theoretical framework and ensure strong cross-cultural applicability (McCoy et al., 2023). Against this backdrop, conducting a review of risk categories in early childhood development and related assessment instruments is essential for synthesizing existing evidence and informing improvements in practice and policy.

2 Review design and literature search strategy

This study employs a narrative review method, conducting systematic retrieval using a combination of subject terms and free words. The retrieval scope covers Chinese databases (CNKI, Wanfang Data, VIP Database) and English databases (PubMed, Embase, Web of Science). To ensure relevance to current global research trends and policy frameworks, studies published between 2000 and 2025 are primarily considered. Taking PubMed as an example, the retrieval strategy is set as follows: (Infant[MeSH] OR Child [MeSH] OR Child, Preschool[MeSH] OR toddler[Ti/Ab]) AND (Child Development[MeSH] OR Developmental Disabilities[MeSH] OR Developmental Delay [MeSH]) AND (Risk Factors[MeSH] OR assessment [Ti/Ab] OR screening[Ti/Ab] OR survey[Ti/Ab] OR tool[Ti/Ab] OR questionnaire[Ti/Ab] OR scale[Ti/Ab]). The inclusion criteria are defined as: ① Original research articles focusing on risk categories or assessment tools related to early childhood development; ② Study types including cross-sectional studies, longitudinal studies, cohort studies, or case-control studies. Exclusion criteria are set as: ① Duplicate publications; ② Non-Chinese and non-English literature; ③ Studies where full texts cannot be obtained. Finally, the research results are integrated and analyzed based on the "Nurturing Care Framework" proposed by the World Health Organization.

3 Risk categories in early childhood development

3.1 Impaired health and physiological function

In early childhood development, adverse condi-

tions in health and physiological functions often constitute the most fundamental source of developmental risks. These risks are typically associated with factors such as harmful fetal exposures, perinatal injuries, intrauterine growth restriction, infectious diseases, inherited metabolic disorders, neurological conditions, sensory system defects, and chronic physical illnesses (Gette et al., 2025). During the phase of rapid neural differentiation and extensive synaptogenesis, these factors may disrupt neuronal migration, myelination processes, and the efficiency of brain network integration (Hwang, Ku, & Hashimoto-Torii, 2019). During the developmental process, such adverse physiological conditions often initially manifest as insufficient motor coordination, abnormal sensory processing, or delayed progress in multiple developmental domains (Leonard, 2016). As the complexity of the learning environment increases, the impact may further extend to executive functions, reading abilities, and social adaptation skills (Ruffini, Bei, & Pecini, 2024). Life course research indicates that early physiological differences may be progressively amplified through "developmental cascade" mechanisms in subsequent developmental stages, transforming initial mild disparities into structural functional gaps (Halfon & Forrest, 2017).

3.2 Nutritional and physical development deviations

Nutritional status and physical growth play a foundational role in early development. When energy intake is insufficient, dietary structure is imbalanced, or key micronutrients are deficient, children may exhibit abnormal growth patterns such as linear growth retardation, underweight, wasting, overweight, or obesity (Dassie et al., 2024). Stunting is often regarded as a composite signal reflecting chronic undernutrition intertwined with multiple adverse environmental conditions, and demonstrates consistent associations with cognitive development levels (Ekholuenetale, Barrow, Ekholuenetale, & Tudeme, 2020). From the perspective of neurodevelopmental mechanisms, iron, iodine, and essential fatty acids play critical roles in neurotransmitter synthesis and myelination processes, with deficiencies potentially impairing attentional control and information processing efficiency (Heland et al., 2022). Concurrently, childhood obesity is associated with chronic low-grade inflammation and meta-

bolic dysregulation, a physiological state that may also affect emotional stability and self-regulatory capacity (Verbiest, Michels, Tanghe, & Braet, 2021). During developmental progression, deviations in physical growth often coincide with restricted activity participation and reduced social interaction opportunities, thereby exerting indirect effects on cognitive and social-emotional competencies (Hill et al., 2024). Longitudinal studies further revealed significant associations between early malnutrition and risks of chronic diseases in adulthood, labor capacity, and socioeconomic status, demonstrating that its effects persist across the life cycle (Kirolos et al., 2024).

3.3 Insufficient responsive care

The quality of caregiving relationships acquired during early childhood serves as a crucial environmental condition for translating neuroplasticity into functional capacities (Callaghan & Tottenham, 2016). Children who fail to establish consistent, stable, and responsive caregiving relationships in their early years face developmental risks in attachment formation, emotional regulation, language comprehension, and social cognition (Bourne, Korom, & Dozier, 2022). When caregivers exhibit chronic neglect, scarce interaction, inconsistent emotional responsiveness, or mental health challenges, children experience significantly reduced language input and emotional support, along with diminished attachment security (Bourne, Korom, & Dozier, 2022). In the early stages, this risk often manifests as inadequate expressive abilities, emotional irritability, or withdrawal behaviors (Clark, Locke, Baxendale, & Seifer, 2022). Upon entering preschool and school-age periods, it may further present as difficulties in peer relationships, insufficient rule-following capacity, and persistent emotional issues (Denham et al., 2012). Research indicates that the quality of early care has long-term predictive effects on social-emotional competence and mental health (Bourne, Korom, & Dozier, 2022), with impacts that are not readily reversible in the short term (Wustmann Seiler, Sticca, Gasser-Haas, & Simoni, 2022).

3.4 Limited access to early learning opportunities

The risks of early learning opportunity deprivation include children's lack of systematic language stimulation, reading activities, structured play, and exploratory learning opportunities during critical devel-

opmental periods, leading to a risk state of developmental delays in executive function, language comprehension, problem-solving abilities, and academic readiness. The experience-dependent plasticity theory indicates that neural connections require reinforcement through repeated and challenging environmental stimuli; otherwise, functional integration efficiency will be compromised (Nelson & Gabard-Durnam, 2020). Longitudinal studies demonstrate that the frequency of home reading is closely associated with children's vocabulary size and reading comprehension skills, while insufficient cognitive stimulation during preschool years shows persistent correlation with subsequent academic underachievement (Killingly, Graham, Tancredi, & Snow, 2025). When such opportunity gap is not identified and addressed prior to school entry, children's disadvantages in classroom task comprehension, self-regulation, and abstract thinking often continue to widen, forming structural educational disparities that affect their subsequent educational trajectories and social mobility opportunities (Carbuccia, Thouzeau, Barone, & Chevallier, 2025).

3.5 Safety and environmental instability

Safety and environmental instability risks refer to the hazardous conditions where children are chronically exposed to family conflicts, economic stress, social violence, frequent changes in caregiving relationships, or highly unpredictable living circumstances, which can exert persistent effects on their stress regulation systems, emotional stability, and behavioral control capacities (Ugarte & Hastings, 2024). Chronic stress may lead to sustained activation of the hypothalamic-pituitary-adrenal axis, alter cortisol secretion rhythms, and impact the development of the prefrontal cortex and hippocampus (Lupien, Juster, Raymond, & Marin, 2018). Research indicates that early adversity exposure is closely associated with emotional hyperactivity and impaired impulse control. During childhood, such instability often manifests as anxiety, aggressive behaviors, or sleep disturbances. If persistent, it significantly increases the likelihood of depressive symptoms, risk-taking behaviors, and social adaptation difficulties during adolescence (Lee, Bernard, & Dozier, 2024). Prolonged environmental instability may also undermine educational continuity and social trust, exerting structural impacts on individual mental health and social functioning (Smith et al., 2025).

4 Risk identification tools in early childhood development

4.1 Health and physiological function risk identification tools

Health status constitutes the biological foundation of early childhood development. Monitoring physical growth is an important approach to identifying health-related developmental risks. The WHO Growth Standards provide Z-scores for length/height, weight, and head circumference for children aged 0-59 months, enabling the identification of stunting, wasting, overweight, and other growth-related risks (Van den Broeck, Willie, & Younger, 2009). Early deviations in neurological and physiological function are also critical indicators for risk identification. The Hammersmith Infant Neurological Examination (HINE), applicable to children aged 3-24 months, is widely used in high-risk infant follow-up to support early identification of neurodevelopmental impairment (Bhandankar & Metgud, 2023).

For broader developmental risk identification, the Denver Developmental Screening Test (Denver II) and the Chinese 0-6-year developmental assessment use direct testing methods (McCoy, Waldman, & Fink, 2018). These tools involve professional observation of children's motor, language, and social performance to identify potential developmental risks and are widely applied in child health and primary care settings. Parent-report instruments such as the Parents' Evaluation of Developmental Status (PEDS) and the Ages & Stages Questionnaires (ASQ-3/ASQ-C) support early risk identification based on caregivers' observations (Sheldrick et al., 2020). The ASQ-C has been validated in multiple regions in China and shows good sensitivity and specificity for identifying developmental risks (Xie et al., 2017).

4.2 Nutrition and physical development risk identification tools

Nutritional risk identification tools primarily include dietary intake surveys, complementary feeding behavior assessments, and long-term growth monitoring. The WHO Infant and Young Child Feeding (IYCF) indicators, designed for children aged 6-23 months, assess feeding practices using measures such as minimum meal frequency, dietary diversity, and timely introduction of complementary foods, thereby

helping identify feeding-related nutritional risks (Daelmans, Dewey, & Arimond, 2009). The indicators offer a simple structure suitable for large-scale population screening.

For more detailed identification of nutritional risk, the Food Frequency Questionnaire (FFQ) and 24-hour dietary recall are commonly used (Louie & Bhowmik, 2026). These methods, applicable from 6 months to preschool age, estimate intake levels of key nutrients such as iron and zinc, allowing identification of potential deficiencies or imbalances (Wakhungu et al., 2024). They are particularly useful in examining nutrition-related developmental risks, including those associated with iron deficiency and cognitive function.

Growth monitoring serves as an indirect but important tool for identifying physical development risks related to long-term nutritional status. IYCF focuses on feeding behaviors, FFQ and dietary recall assess nutrient intake patterns, and growth monitoring reflects cumulative nutritional influences on physical development (Tahreem et al., 2025). Although FFQ provides relatively detailed intake data, caregiver recall may introduce bias; IYCF is simpler and more feasible for large-scale screening but offers limited information on specific nutrient quantities (Saravia et al., 2021).

4.3 Risk identification tools for inadequate responsive caregiving

Insufficient responsive caregiving represents a significant developmental risk, particularly for language, social-emotional functioning, and executive skills. Several standardized tools have been used to assess the risk of inadequate caregiver responsiveness. The Home Observation for Measurement of the Environment (HOME) includes subscales evaluating emotional and verbal responsiveness of caregivers (Bradley, 1989). Although HOME broadly measures the home environment, its responsiveness-related domains are commonly used to assess the risk of limited responsive caregiving in children from birth to three years (Fuligni, Han, & Brooks-Gunn, 2004).

Parent-child interaction observational measures are central tools for directly assessing caregiver responsiveness. These tools use structured observations or video recordings to evaluate caregiver sensitivity, emotional availability, and contingent responding to child cues (Edwards et al., 2021). Low scores on re-

sponsiveness and sensitivity dimensions indicate elevated risk of inadequate responsive caregiving.

The Language ENvironment Analysis (LENA) system provides an objective assessment of language-based responsiveness by recording naturalistic language interactions through wearable devices (Levin-Asher, Segal, & Kishon-Rabin, 2023). Indicators such as reduced adult word counts and fewer conversational turns are associated with lower levels of verbal responsiveness and may signal risk in language-related caregiving interactions (Salo et al., 2022). Together, these tools assess different dimensions of responsive caregiving risk, including emotional responsiveness, behavioral contingency, and verbal interaction patterns.

4.4 Risk identification tools for insufficient early learning opportunities

Early learning opportunities emphasize exploration, language, and cognitive engagement in daily life rather than formal academic instruction. Representative tools for assessing home learning environments include Home Learning Environment Questionnaire (HLEQ). The HLEQ is a widely used instrument designed to assess the quality and frequency of early learning experiences provided in the home environment. Grounded in developmental and ecological theories, the HLEQ focuses on everyday interactions and activities that promote children's cognitive, linguistic, and socio-emotional development, rather than formal academic instruction (Krousorati et al., 2022).

4.5 Risk identification tools for child safety and environmental instability

Child safety and environmental stability are foundational conditions for healthy early development. Exposure to unsafe living conditions, household instability, and inadequate supervision constitutes significant developmental risk (DeCandia, Volk, & Unick, 2022). Risk identification tools in this domain focus on assessing household safety conditions, environmental organization, and caregiving practices that may affect children's exposure to harm.

In home settings, structured household assessment tools are commonly used to evaluate environmental risk factors that may affect children's health and development. One such instrument is the Child Housing Assessment for a Safe Environment

(CHASE), a standardized observational tool designed to systematically identify housing-related hazards in residences where young children live (Shields et al., 2020). A key strength of CHASE lies in its structured and standardized format, which allows for consistent documentation of environmental conditions and facilitates comparisons across households and studies. Scoring procedures generally involve identifying and summing observed hazards to generate indices of cumulative environmental risk. Higher scores indicate greater exposure to potential safety and health threats within the home environment.

4.6 Multidimensional developmental risk identification tools

Since the 1990s, several population-level early childhood development (ECD) assessment tools have been developed to evaluate multiple developmental domains. Although designed to assess developmental abilities, these instruments are also used to identify multidimensional developmental risk. The Early Development Instrument (EDI), completed by teachers for children aged 3.5-6.5 years, assesses multiple domains of school readiness (Nair, Radhakrishnan, & Olusanya, 2023). Lower domain scores may indicate elevated developmental risk. The Early Human Capability Index (eHCI) covers 10 domains for children aged 3-6 years and has been implemented in several countries (Robinson et al., 2015). Children scoring below expected levels can be identified as at risk across domains. The East Asia-Pacific Early Child Development Scales (EAP-ECDS) assesses developmental domains in children aged 3-5 years and has demonstrated reliability and validity in six countries. It can identify children with developmental vulnerability in specific domains (Rao, Su, & Chan, 2024).

For children aged 0-3 years, the Caregiver-Reported Early Development Index (CREDI) includes short and long forms and has been applied across multiple countries (McCoy, Waldman, & Fink, 2018). It captures early developmental domains, and lower scores may signal multidimensional developmental risk. Similarly, the WHO-developed Infant and Young Child Development (IYCD) tool assesses early developmental domains for children aged 0-3 years and can be used to identify developmental risk at the population level (Lancaster et al., 2018).

The tools described above cover multiple dimen-

sions of early childhood developmental risk. These instruments provide structured approaches for identifying risk within specific domains as well as across broader developmental systems. However, recent research has increasingly emphasized the use of multidimensional assessment tools that integrate multiple domains within a single framework. This shift reflects growing recognition that developmental risk is shaped by interacting biological and environmental factors, and that comprehensive tools offer a more coordinated approach to identifying developmental vulnerability at both individual and population levels.

5 Conclusion

Early childhood development is characterized by high plasticity and heightened vulnerability to multidimensional risks. The types of risks influencing development are diverse and interrelated, encompassing biological and physiological conditions, nutritional deficiencies, inadequate responsive caregiving, limited early learning opportunities, and broader environmental instability. This review systematically categorized major types of developmental risk and summarized corresponding risk identification tools based on recent global research. Overall, approaches to early childhood developmental risk identification have evolved from single-domain screening toward more integrated, multidimensional, and cross-cultural assessment frameworks.

Future research should further strengthen risk classification and identification systems in three areas. First, many existing tools remain cross-sectional and static, limiting their ability to capture the dynamic and cumulative nature of risks related to health, nutrition, caregiving, and stress exposure. Longitudinal and multidimensional identification systems are needed to monitor risk trajectories across developmental stages and enhance early detection and targeted intervention. Second, as multidimensional assessment tools are increasingly implemented across countries, ensuring cross-cultural validity has become essential. Variations in caregiving norms and developmental expectations require culturally grounded adaptation, representative sampling, and contextual calibration to maintain measurement stability. Third, risk identification systems should be embedded within policy cy-

cles of monitoring, intervention, and reassessment, thereby linking assessment results to actionable responses and promoting equitable developmental opportunities.

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Data availability statement

No new data were generated or analyzed in this study. Data sharing is not applicable to this article.

Conflict of interest

The authors declare that they have no conflict of interest.

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