REVIEW ARTICLE

Annals of Agricultural and Environmental Medicine
www.aaem.pl

Implementation of ICD-11 for Pediatric Neurodevelopmental Disorders: Clinical Challenges, Organizational Readiness, and Ensuring Equitable Access to Care Across Regional Disparities

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A – Research concept and design, B – Collection and/or assembly of data, C – Data analysis and interpretation, D – Writing the article, E – Critical revision of the article, F – Final approval of the article

Barłóg M, Droździel P, Sobieszczańska-Droździel A, Barłóg K, Samardakiewicz M. Implementation of ICD-11 for Pediatric Neurodevelopmental Disorders: Clinical Challenges, Organizational Readiness, and Ensuring Equitable Access to Care Across Regional Disparities. Ann Agric Environ Med. doi:10.26444/aaem/241923

Abstract

Introduction and Objective. The transition from ICD-10 to ICD-11 reshapes the classification of paediatric neurodevelopmental disorders toward dimensional and function-oriented assessment. This review examines changes concerning Attention-Deficit/Hyperactivity Disorder (ADHD), Autism Spectrum Disorder (ASD), and Developmental Learning Disorders (DevLD), focusing on implementation and regional inequalities in access to care.

Review Methods. The critical narrative review examine ICD-11 revisions and their clinical, organizational, and health-system implications. Findings informed the proposed Integrated ICD-11 Neurodevelopmental Clinical Model (ICD-11-INCM), a conceptual framework requiring empirical validation.

Brief description of the state of knowledge. ICD-11 emphasizes functional impairment, co-occurring conditions, and individualized support needs. Implementation depends on professional competencies, multidisciplinary resources, organizational readiness, and healthcare capacity. In under-resourced rural and community settings, staff shortages and inadequate referral pathways may impede access and increase pressure on primary care. Greater diagnostic flexibility may change referral patterns and increase demand for specialist assessment. Digital health and Medicine 4.0 are potential secondary supports, but as yet are unestablished solutions.

Summary. Equitable implementation of ICD-11 requires coordinated clinical, organizational, and health-system measures that address regional inequalities and resource constraints. The proposed ICD-11-INCM model may inform implementation planning; however, the conclusions should be interpreted in light of the narrative review design, lack of empirical validation, and the heterogeneity of healthcare systems.

Key words

ADHD, ICD-11, autism spectrum disorder, neurodevelopmental disorders, developmental learning disorders, Medicine 4.0

INTRODUCTION

The International Classification of Diseases (ICD), developed by the World Health Organization (WHO), constitutes the principal global system for the classification of diseases and health-related conditions. Its significance extends beyond epidemiological purposes, as ICD plays a key role in healthcare systems by directly influencing diagnostic processes, eligibility for therapeutic interventions, reimbursement pathways, and access to medical and psychological services [1]. For this reason, ICD revisions should not be regarded as purely technical updates but rather as system-level changes with important clinical and public health consequences.

The transition from ICD-10 to ICD-11 represents a substantial conceptual and structural shift, particularly in the domain of mental, behavioural, and neurodevelopmental disorders. ICD-10, developed in the late twentieth century, was based on a categorical approach in which diagnostic entities were defined primarily by the presence of specific symptoms and fixed diagnostic thresholds [2]. Despite its widespread implementation and important role in standardizing psychiatric diagnosis, ICD-10 has been criticized for limited diagnostic flexibility, reduced clinical utility in capturing complex and heterogeneous clinical presentations, and insufficient incorporation of dimensional

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Received: 02.09.2026; accepted: 18.10.2026; first published: 13.11.2026

approaches to psychopathology [3]. These limitations are particularly evident in paediatric populations, where developmental variability and symptom overlap across neurodevelopmental conditions complicate categorical diagnosis [4]. This may lead to diagnostic uncertainty in subthreshold or atypical presentations with clinically significant impairment [5].

Autism spectrum disorders illustrate the limitations of the ICD-10 categorical framework, which produced substantial diagnostic heterogeneity, whereas current evidence supports a spectrum-based conceptualization [6]. Similar concerns apply to attention-deficit/hyperactivity disorder (ADHD), where restrictive criteria may have contributed to underdiagnosis in atypical presentations [7]. In developmental learning disorders, ICD-10 has likewise been criticized for insufficiently capturing the heterogeneity of underlying cognitive and linguistic profiles, which are increasingly conceptualized as multidimensional neurocognitive phenomena [8, 9]. ICD-11 addresses these limitations by introducing conceptual changes that place greater emphasis on developmental and dimensional approaches, improved clinical utility, and better alignment with current knowledge in developmental neuroscience and psychopathology [3]. Importantly, ICD-11 was designed with clinical utility in mind, which is particularly relevant for a wide range of healthcare professionals, including psychiatrists, psychologists, paediatricians, and primary care physicians, thereby enhancing the potential for personalized care delivery [10].

From a translational perspective, these changes have direct implications for diagnostic pathways, clinical decision-making, and the organization of access to healthcare services in children and adolescents [3]. These considerations are particularly relevant in rural, remote, and geographically underserved communities, where implementation of revised diagnostic frameworks may interact with pre-existing disparities in access to specialist healthcare. Evidence from autism research indicates that rural communities may experience barriers to diagnostic, treatment, and support services, including limited availability of specialized professionals, geographical distance, and difficulties accessing specialized assessment pathways [11].

Importantly, empirical evidence from rural and underserved healthcare settings suggests that organizational redesign may improve the timeliness of neurodevelopmental assessment. In one study, implementation of a streamlined autism diagnostic consultation model within primary care was associated with a reduction in the mean time from initial developmental concern to diagnostic decision from 144.7 to 49.9 days and reduced referrals to tertiary diagnostic centres [12]. These findings do not establish an effect of ICD-11 itself on diagnostic timeliness, but they illustrate how the organization and distribution of diagnostic capacity may influence access to neurodevelopmental assessment. Consequently, regional differences in healthcare infrastructure, workforce availability, and referral pathways should be considered when evaluating the implementation of ICD-11 in paediatric neuro-developmental practice, particularly in smaller community-based facilities and rural areas.

In contrast to earlier descriptive accounts of the ICD-11 revisions [3], this review focuses on the clinical and translational implications of these changes in paediatric practice, with particular emphasis on their impact on diagnostic decision-making, interdisciplinary collaboration, organization of healthcare pathways, and equitable access to care. In this context, the development of competencies related to interdisciplinary communication, digital literacy, data-informed decision-making, and adaptive problem-solving may support the delivery of integrated and personalized care models, particularly in digitally enabled healthcare settings [10].

The aim of the review is to critically synthesize the key changes introduced in ICD-11 with respect to neurodevelopmental disorders in childhood and adolescence, with special emphasis on attention-deficit/hyperactivity disorder, autism spectrum disorder, and developmental learning disorders, and to propose an original author-developed model integrating diagnostic, clinical, organizational, and system-level dimensions of ICD-11 implementation.

REVIEW METHODS

A critical literature review was conducted to examine the conceptual and diagnostic changes introduced by the eleventh revision of the International Classification of Diseases (ICD-11) in neurodevelopmental disorders. Literature was identified through searches of PubMed, Scopus, Web of Science, and Google Scholar conducted between February – September 2026, using terms related to ICD-11/ICD-10, neurodevelopmental disorders (including ADHD, ASD, and developmental learning disorders), developmental psychopathology, classification systems, Medicine 4.0, digital health, telehealth, primary and paediatric care, workforce shortages, rural healthcare, and healthcare access. Additional searches addressed regional disparities, rural and underserved populations, healthcare workforce distribution, referral pathways, and organizational readiness to capture variation in ICD-11 implementation across healthcare settings.

Priority was given to English-language peer-reviewed empirical studies, systematic and scoping reviews, clinical and implementation studies, conceptual papers, international guidelines, and relevant WHO classification documents published between 2010 – 2026, with particular attention to ICD-11 revisions, dimensional and transdiagnostic approaches, clinical utility, workforce distribution, digital health implementation, and access to neurodevelopmental services in rural and underserved populations. The review does not report original patient-level data or a prospective clinical implementation study; instead, findings from previously published studies were critically integrated with ICD-11 principles to develop the proposed Integrated ICD-11 Neurodevelopmental Clinical Model (ICD-11-INCM), which is a conceptual implementation framework requiring future empirical validation.

Key diagnostic changes in ICD-11 for neurodevelopmental disorders. Neuro- developmental disorders are a group of multifactorial conditions with an early developmental onset and a chronic course, affecting cognitive, social, and communication functioning [13]. In response to advances in developmental psychiatry and neuroscience, ICD-11 introduced a substantial reorganization of neurodevelopmental disorders, reflecting contemporary dimensional and lifespan-oriented models of psychopathology [14]. This perspective is

supported by evidence suggesting that many adult psychiatric disorders have developmental origins and may first emerge or become detectable during the early stages of life. Conversely, diagnostic frameworks used in paediatric populations have historically been largely derived from classification systems developed within adult psychiatry, although more recent revisions have increasingly incorporated a lifespan-oriented and developmental approach [15].

Notably, in contrast to ICD-10, which distributed neurodevelopmental conditions across several diagnostic groupings, including mental retardation, disorders of psychological development, and behavioural and emotional disorders such as ADHD and tic disorders, ICD-11 reorganizes these conditions within a unified grouping of neurodevelopmental disorders and adopts a more integrated developmental and dimensional framework [1, 2]. Within ICD-10, the diagnostic approach was highly fragmented, dividing conditions into numerous narrow categories and separating speech, learning, and pervasive developmental disorders. Within this framework, a spectrum-based perspective was not fully integrated, and diagnostic practice often involved assigning multiple distinct diagnostic categories. In contrast, ICD-11 adopts a more integrated and dimensional approach, with greater emphasis on the heterogeneity of clinical presentation, functional impairment, and support needs. ICD-11 also permits ASD and ADHD to be diagnosed as co-occurring conditions when the diagnostic requirements for both disorders are met [3]. This is clinically relevant because ADHD-related symptoms may also be present in children with ASD [16].

Autism spectrum disorder. In ICD-10, pervasive developmental disorders comprised eight distinct diagnostic categories, including childhood autism, atypical autism, Asperger syndrome, and other pervasive developmental disorders [2]. In ICD-11, these conditions are subsumed under a single diagnosis of autism spectrum disorder, reflecting a spectrum-based conceptualization in which difficulties are viewed from a broader developmental and functional perspective rather than solely in terms of discrete categorical subtypes [1, 17]. To account for substantial phenotypic heterogeneity within this diagnostic category, ASD diagnoses are supplemented with specifiers [18].

In this sense, the autism spectrum encompasses individuals across different levels of intellectual development within a single diagnostic category, while specifiers provide additional information regarding the presence of a co-occurring disorder of intellectual development, the degree of functional language impairment, and the presence or absence of loss of previously acquired skills [1]. A further change introduced in ICD-11 is the adoption of a lifespan developmental perspective on ASD, with diagnostic requirements no longer restricted to symptom onset before the age of three years, as in ICD-10 [19].

Importantly, ICD-11 adopts a two-domain structure for ASD, comprising persistent deficits in social communication and reciprocal social interaction, and restricted, repetitive, and inflexible patterns of behaviour. Consequently, the degree of functional language impairment is specified separately rather than forming an independent core diagnostic domain [1]. Reflecting this broader conceptual shift, Greaves-Lord et al. emphasize that diagnostic assessment should be used to tailor interventions and provide support for an individual's capacities and genuine needs [20].

Attention deficit hyperactivity disorder (ADHD). In ICD-10, ADHD was primarily represented by the category of hyperkinetic disorder, a more narrowly defined condition requiring symptoms of inattention, hyperactivity, and impulsivity [2, 21]. In contrast, ICD-11 conceptualizes attention deficit hyperactivity disorder as a neurodevelopmental disorder and allows the current clinical presentation to be specified as predominantly inattentive, predominantly hyperactive-impulsive, or combined [1, 21]. ICD-11 also recognizes that ADHD may persist into adulthood, extending the applicability of the diagnosis across the lifespan [1]. Moreover, in ICD-10, pervasive developmental disorders were exclusionary for hyperkinetic disorder, preventing the concurrent diagnosis of ASD and ADHD [22]. In ICD-11, this exclusion was removed, allowing ASD and ADHD to be diagnosed as co-occurring conditions when the diagnostic requirements for both disorders are met [1, 14].

The age-of-onset criterion has also been broadened, from seven years in ICD-10 to 12 years in ICD-11, while the clinical guidance recognizes that ADHD symptoms may become more apparent when increasing developmental, academic, occupational, or social demands exceed an individual's capacity for self-regulation [1, 21]. Finally, whereas ICD-10 primarily framed hyperkinetic disorder within childhood and adolescence, ICD-11 adopts a lifespan perspective and emphasizes clinically significant symptoms and associated functional impairment across relevant areas of daily life [1, 21].

Developmental learning disorders. ICD-11 defines developmental learning disorder as persistent difficulties in the acquisition and use of academic skills and recognizes domain-specific manifestations through specifiers indicating impairment in reading, written expression, and/or mathematics [1]. In ICD-10, these difficulties were classified under separate diagnostic categories within the group of specific developmental disorders of scholastic skills, including dyslexia, dyscalculia, and dysgraphia [2].

Notably, ICD-11 conceptualizes developmental learning disorder as a unified diagnostic category while specifying the affected academic domain (reading, written expression, and/or mathematics) and allowing for the recognition of co-occurring impairments across these domains [1]. In particular, reading difficulties are explicitly recognized, while spelling disorder has been incorporated into the broader domain of impairment in written expression [23]. ICD-11 further maintains exclusion criteria to ensure that these difficulties are not better explained by disorder of intellectual development, sensory impairment, or inadequate educational exposure [1, 24]. ICD-11 adopts a more integrated developmental framework that prioritizes functional impact, developmental variability, and individual support needs [3, 18]. Although these conditions remain distinct diagnostic entities, ICD-11 groups them within a broader neurodevelopmental framework that acknowledges developmental continuity, frequent overlap between disorders, and their impact on everyday functioning [14, 18].

Practical implications of ICD-11 for paediatric practice. The transition to ICD-11 may be associated with greater complexity of clinical decision-making, which may increase the cognitive demands placed on clinicians [25]. In child

and adolescent mental health care, diagnostic classification plays an important role in diagnostic pathways, intervention planning, the organization of care, and interdisciplinary collaboration [3]. These challenges are particularly relevant in paediatric practice because developmental variability requires differentiation between age-related characteristics and clinically significant pathology. The increased diagnostic specificity of ICD-11 may support more precise identification of neurodevelopmental, behavioural, and chronic paediatric disorders and may facilitate appropriate referrals to specialized services [1, 26].

The revised structure of ICD-11 may improve diagnostic consistency across clinical settings, facilitate communication and continuity of care, and support more individualized treatment planning [3]. Although implementation may initially require additional training and adaptation of clinical and administrative processes, long-term adoption may contribute to improved diagnostic precision and interoperability between healthcare sectors [1, 26].

ICD-11 implementation may also increase the relevance of digital-health competencies, including digital literacy, data-informed decision-making, problem-solving, collaboration, and adaptability. These competencies may facilitate the integration of clinical information across multidisciplinary teams and support the use of digital tools for referral, consultation, and information exchange [27]. Consequently, diagnostic formulation may involve combining categorical classification with dimensional assessment of symptoms and their functional impact [1, 3].

For attention-deficit/hyperactivity disorder (ADHD), the broader ICD-11 framework may help address diagnostic challenges in individuals with predominantly inattentive symptoms or later symptom onset. Clinical assessment therefore requires detailed developmental history and integration of information from multiple sources, particularly family and school settings, while distinguishing clinically significant impairment from normative developmental variability [7]. Effective interviewing and communication skills are also important in this process [10].

For autism spectrum disorder (ASD), consolidation of previously separate diagnostic categories into a single spectrum diagnosis requires clinicians to focus on individual functioning in social communication and restricted and repetitive behaviours rather than diagnostic subtypes. Although this may contribute to greater diagnostic consistency, it also requires careful assessment of heterogeneous, borderline, and atypical presentations [6].

For developmental learning disorders, including dyslexia, ICD-11 encourages a more integrated consideration of cognitive, linguistic, and educational functioning. This approach may support the recognition of heterogeneous profiles and more individualized, multidisciplinary intervention planning [8, 9].

These changes also highlight the relevance of competencies aligned with Medicine 4.0, particularly the integration of multisource data, the use of digital diagnostic tools, and the incorporation of data-informed information into clinical decision-making [27, 28]. Such competencies extend beyond technical proficiency to include interdisciplinary collaboration and adaptability to evolving technologies [27, 28]. However, workforce shortages and limited digital-health competencies may constrain the implementation of coordinated neurodevelopmental care, particularly in underserved settings [29–31].

At the healthcare-system level, ICD-11 implementation may affect the organization of paediatric services and access to care. More inclusive diagnostic criteria may increase the number of children meeting criteria for neurodevelopmental disorders, and consequently increase demand for specialist services and resources [3]. Conversely, greater diagnostic precision may help reduce misclassification, facilitate more targetted interventions, and contribute to more appropriate use of healthcare resources [3, 32].

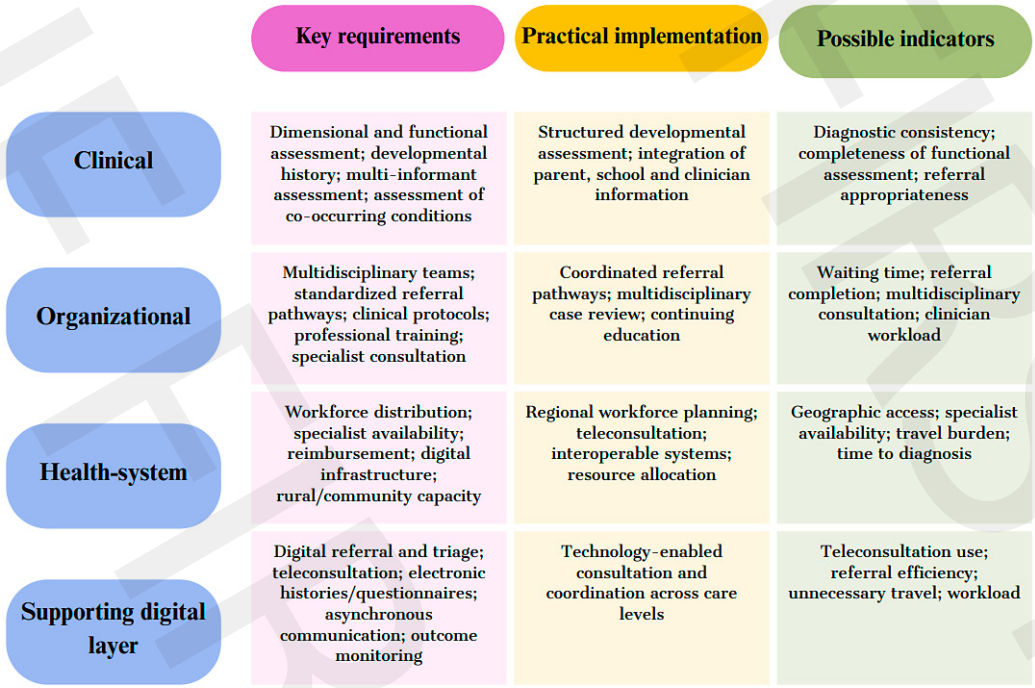


Figure 1. Clinical, organizational, and health-system requirements for implementation of ICD-11 in pediatric neurodevelopmental care
Source: author's own work

Empirical evidence for digital and distributed models of neurodevelopmental care. The practical relevance of Medicine 4.0 in neurodevelopmental care can be understood in terms of digital and organizational tools that may support selected diagnostic, communication, and care-coordination tasks across healthcare levels. This distinction is particularly important in primary care and paediatric settings characterized by shortages of developmental-behavioural specialists, child and adolescent psychiatrists, psychologists, and other professionals involved in neurodevelopmental assessment [30]. Empirical evidence indicates that organizational redesign and primary-care-based diagnostic capacity can improve access to neurodevelopmental assessment in underserved communities. Hine et al. [12] evaluated a streamlined autism diagnostic consultation model embedded within primary care clinics serving rural and underserved populations. Implementation reduced the mean time from initial developmental concern to diagnostic decision and decreased referrals to tertiary diagnostic centres, demonstrating that selected components of specialist assessment can be reorganized closer to primary care, and that diagnostic accessibility depends partly on the organization of diagnostic pathways [12].

Digital technologies may further extend primary-care capacity without requiring specialist functions to be physically relocated. A systematic review of telehealth diagnostic assessment for autism spectrum disorder and developmental language disorder identified 18 studies and found generally comparable validity and reliability to traditional approaches, although limitations remained, particularly in differentiating autism spectrum disorder from developmental language disorder [33]. Telehealth therefore appears most appropriate as an adjunct to, rather than a universal replacement for, comprehensive face-to-face multidisciplinary assessment. Recent empirical work similarly found high agreement between expert telehealth assessments and final diagnostic decisions when clinicians expressed high diagnostic confidence [34]. This supports a tiered pathway in which digitally supported specialist consultation may assist triage and decision-making, while diagnostically complex or uncertain cases can be referred for comprehensive in-person assessment [34].

The need for such models is reinforced by geographic and workforce disparities. Analyses of paediatric provider distribution have identified substantial regional differences in the availability of general and specialized paediatricians, including areas where lower specialist availability coincides with relatively high estimated prevalence of autism spectrum disorder and attention-deficit/hyperactivity disorder [35]. National survey data from primary care paediatricians likewise identify long waiting times, insufficient specialist numbers, and travel requirements as major barriers to subspecialty care, particularly in child and adolescent psychiatry and developmental-behavioural paediatrics; shortages are reported more frequently by rural than nonrural paediatricians [31]. Workforce analyses further demonstrate substantial regional variation and an overall insufficient supply of developmental-behavioural paediatricians relative to estimated population needs [30].

Accordingly, Medicine 4.0 should be operationalized within the ICD-11-INCM (Fig. 2) as a set of specific clinical and organizational functions rather than as a generic reference to digital transformation. These include electronic sharing of developmental histories and standardized questionnaires, digital referral and triage systems, and structured monitoring of waiting times and referral outcomes. Such tools can support the collection and integration of multisource information while preserving specialist involvement in diagnostically complex cases. The aim is not to replace specialist expertise with technology, but to extend specialist reach, reduce unnecessary travel and duplicated assessments, support primary-care clinicians, and create more efficient escalation pathways [33, 34]. This distinction is particularly important in rural and resource-constrained settings, where technology can improve connectivity but cannot independently compensate for insufficient workforce capacity or limited organizational capacity. A systematic review of digital and remote health interventions in underserved or rural paediatric populations similarly indicates that such approaches may improve access to care, while their effectiveness depends on appropriate implementation within local healthcare systems [36].

Within the proposed ICD-11-INCM, Medicine 4.0 can therefore be conceptualized as an implementation layer connecting the micro-level Functional Developmental Profile with meso-level diagnostic pathways and macro-level resource distribution. In practice, this involves enabling primary-care clinicians to conduct structured initial assessments, obtain specialist input when required, and transfer diagnostically complex cases to specialized services through coordinated digital pathways [34]. Future implementation studies should evaluate whether these digitally supported pathways reduce diagnostic waiting times, improve referral appropriateness, decrease unnecessary travel, increase access to specialist consultation, and maintain diagnostic quality across urban, rural, and underserved settings.

DISCUSSION

The implementation of ICD-11 in paediatric neurodevelopmental care supports a more integrative approach in which categorical diagnosis is considered alongside symptom severity, functional impact, and developmental context [1, 3, 18]. Such an approach may improve differential diagnosis and strengthen the link between diagnostic formulation and subsequent intervention [3, 18].

For ADHD, assessment should be multi-informant and multisource, incorporating information from different settings and considering functional impairment alongside core symptoms [7, 21]. For autism spectrum disorder (ASD), clinicians should focus on the individual functional profile rather than narrow diagnostic subtypes, including assessment of social communication, restricted and repetitive behaviours, adaptive functioning, and heterogeneous presentations [6]. In developmental learning disorders, psychological, educational, speech and language, and neuropsychological perspectives may be integrated through interdisciplinary collaboration, supporting individualized therapeutic and educational strategies [8–10].

Personalized care within the ICD-11 framework therefore requires classification to function as a clinically useful framework for diagnostic formulation and communication rather than solely as an administrative system, supported by interdisciplinary collaboration and appropriately

trained professionals [1, 3, 10]. This includes competencies in dimensional and functional reasoning, evidence-based practice, interdisciplinary work, digital literacy, data-informed decision-making, and adaptive problem-solving, although the relative importance of these competencies may vary according to clinical and organizational context [27–29]. Continuous professional development and updating of medical education are particularly important in the context of evolving digital health competencies and changing workforce and service-delivery needs [29–31].

Effective ICD-11 implementation also requires organizational capacity, including standardized diagnostic procedures, coherent referral and treatment pathways, multidisciplinary coordination, and appropriate integration of digital technologies into clinical workflows [1, 3, 18, 29]. Healthcare professionals increasingly need competencies that allow them to use digital health technologies and integrate information from multiple clinical and informational sources within coordinated care processes [27–29]. Interdisciplinary communication, collaboration, and adaptive clinical decision-making are essential when addressing diagnostic uncertainty, heterogeneous presentations, and changing clinical information [10, 27]. Medicine 4.0 competencies should therefore be understood as context-dependent capabilities that support and extend clinical expertise rather than as substitutes for professional clinical judgment [27–29].

A transdiagnostic and developmental perspective, exemplified by the ESSENCE concept. further emphasizes the overlap among ADHD, ASD, and developmental learning disorders and supports their consideration within a broader, interconnected pattern of developmental difficulties rather than as strictly isolated categorical entities [37]. At the same time, ICD-11 implementation presents challenges related to variability in clinician training, health-system readiness, and the need to maintain diagnostic consistency during the transition between classification systems [15, 18].

Greater diagnostic flexibility and a spectrum-oriented framework could alter referral patterns and increase the number of children considered for further assessment, particularly those presenting with borderline, heterogeneous, or overlapping developmental profiles; however, the magnitude and direction of such effects are likely to depend on local diagnostic practices, workforce capacity, and service organization, and should therefore be regarded as potential implementation consequences rather than established universal effects [15, 18]. Such challenges may be particularly relevant when increased diagnostic flexibility is not accompanied by adequate training, standardized assessment, and systematic consideration of developmental context and functional impairment [18].

Spectrum-based classification should therefore not be interpreted as lowering diagnostic standards or allowing isolated symptoms to establish a diagnosis. Diagnosis should remain based on the overall developmental pattern, persistence and configuration of symptoms, clinically significant functional impairment, and appropriate differential diagnosis [1, 3, 18]. Differences between diagnostic frameworks may also affect the proportion of individuals meeting diagnostic criteria, as demonstrated by comparative analyses of ICD-11 and DSM-5 criteria for developmental reading disorders [24]. Changes in diagnostic prevalence should therefore be interpreted cautiously [24]. An increase in diagnoses may reflect improved identification of previously unrecognized cases, but the potential risk of over-diagnosis should also be considered, particularly when diagnostic standards are not consistently applied.

More inclusive or flexible diagnostic frameworks may increase demand for specialist assessment and may therefore require corresponding adjustment of healthcare resources and organizational structures [15, 18, 30, 31]. These implications are particularly important in primary care and resource-constrained settings, where insufficient specialist capacity may lengthen referral pathways and reduce service availability for children with complex needs [30, 31]. Rural and geographically underserved areas may be especially affected because access to multidisciplinary diagnostic expertise is already limited [12, 35]. Evidence from such settings indicates that strengthening diagnostic capacity within primary care can reduce delays in autism assessment and may facilitate earlier access to intervention and support services, suggesting that the consequences of implementing diagnostic frameworks depend not only on the classification system itself, but also on the organization and capacity of local healthcare services [12]. At the same time, more consistent diagnostic formulation may facilitate identification of clinical needs and planning of individualized interventions, while documented disparities in the timing and pathways of autism diagnosis highlight the need to consider equity across patient groups and healthcare settings [38].

Accordingly, effective implementation requires continuous monitoring of diagnostic rates, referral patterns, waiting times, and healthcare resource utilization, together with standardized diagnostic pathways, clear referral criteria, specialist consultation, multidisciplinary assessment of complex cases, and continuing professional education [15, 18, 30, 31]. Overall, ICD-11 implementation should be understood as a coordinated clinical, organizational, and system-level process requiring appropriate professional competencies, service capacity, and digital infrastructure [1, 3, 18, 29].

Figure 2 illustrates the Integrated ICD-11 Neurodevelopmental Clinical Model (ICD-11-INCM), depicting the interaction between micro-, meso-, and macro-level processes and showing how clinical assessment, diagnostic frameworks, and healthcare-system factors converge on the Functional Developmental Profile (FDP), which guides individualized intervention planning.

Limitations and future validation of the ICD-11-INCM. Several limitations should be considered when interpreting the proposed Integrated ICD-11 Neurodevelopmental Clinical Model (ICD-11-INCM).

First, the present study is based on a critical and narrative literature review rather than a formal systematic review. Although multiple databases were searched and priority was given to empirical, systematic, scoping, clinical, and implementation studies, publication and selection bias cannot be excluded. Furthermore, the inclusion of English-language publications may have resulted in language bias and under-representation of evidence from non-English-speaking healthcare systems.

Second, the model is conceptual and has not yet been empirically validated in clinical settings. The relationships proposed between clinical assessment, organizational readiness, digital competencies, and system-level

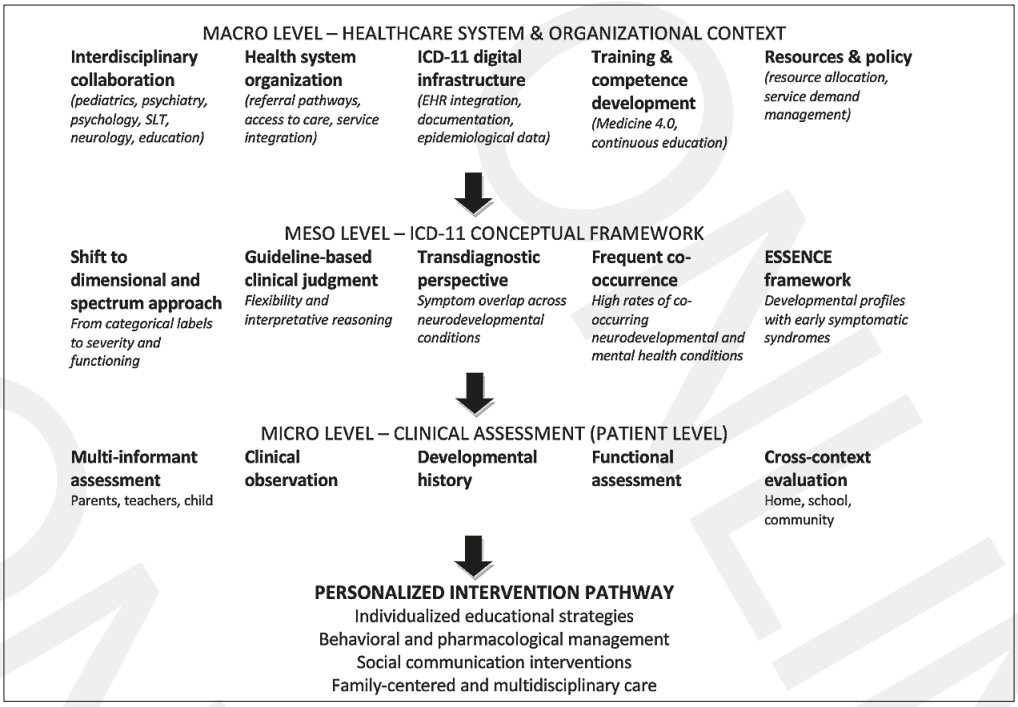


Figure 2. Integrated ICD-11 Neurodevelopmental Clinical Model (ICD-11-INCM).
Source: author's own work

determinants, should therefore be considered theoretically informed rather than established as causal relationships.

Third, the applicability of the model may vary across healthcare systems because differences in workforce availability, reimbursement mechanisms, regulatory requirements, referral pathways, multidisciplinary capacity, and digital infrastructure may influence the feasibility of ICD-11 implementation.

Fourth, the incorporation of Medicine 4.0 technologies should not be assumed to automatically improve access or diagnostic quality. Digital health implementation may remain constrained by limited broadband connectivity, interoperability problems, insufficient professional training, technology-related workload, and inequalities in patients' and families' access to digital resources [27, 29].

Fifth, the ICD-11-INCM does not provide a validated quantitative algorithm for diagnostic prioritization, referral allocation, or distribution of healthcare resources. It should therefore be regarded as a clinical and organizational framework supporting professional decision-making rather than as a substitute for clinical judgment.

Finally, the model has not yet been evaluated with respect to diagnostic accuracy, inter-rater consistency, waiting times, clinician workload, family burden, referral appropriateness, or equity of access. Future prospective implementation studies should therefore examine whether application of the ICD-11-INCM improves coordination of care, diagnostic consistency, timeliness of assessment, and equitable access to neurodevelopmental services across different healthcare settings, including rural and resource-constrained regions.

CONCLUSIONS

The transition from ICD-10 to ICD-11 represents a fundamental shift in the classification of neurodevelopmental disorders, moving from a predominantly categorical system toward a more dimensional, developmental, and function-oriented framework. This transformation enhances clinical relevance by better reflecting the heterogeneity, developmental continuity, and frequent co-occurrence of neurodevelopmental conditions observed in paediatric populations, particularly in attention-deficit/hyperactivity disorder, autism spectrum disorder, and developmental learning disorders.

Importantly, the practical benefits of ICD-11 implementation are unlikely to be distributed equally across all healthcare settings. The extent to which the new diagnostic framework can be effectively applied will depend on the availability of specialists, organizational capacity, institutional resources, digital readiness, and the competencies of healthcare professionals. These differences may be particularly relevant in healthcare systems characterized by disparities in access to specialized services and differences in the timing and pathways of neurodevelopmental diagnosis across patient groups [38].

Therefore, ICD-11 implementation should not be considered solely as an update of diagnostic classification, but also as a component of healthcare system development aimed at improving the quality, accessibility, and coordination of care for children with neurodevelopmental disorders. Future research should evaluate how ICD-11 implementation influences healthcare accessibility, interdisciplinary collaboration, and diagnostic consistency across diverse healthcare contexts, including primary care, specialist centres, and resource-limited or rural environments.

ONLINE FIRST

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