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The Adverse Digital Childhood Experiences (ADCEs) Framework: A Transformative Paradigm for Decoding Digital Adversity and Safeguarding Human Agency in Child Development and Lifespan Trajectories

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Abstract

Childhood is no longer confined to physical spaces; It increasingly unfolds within digitally saturated environments where algorithmically mediated technologies shape attention, learning, and identity formation from the earliest years. Traditional adversity frameworks, particularly the Adverse Childhood Experiences (ACEs) model, do not capture the distinctive, persistent, and often invisible risks of digital life. To address this gap, this study advances the Adverse Digital Childhood Experiences (ADCEs) framework, an empirically informed and theory-driven extension of ACEs that systematizes ten interrelated domains of digital adversity encompassing social, cognitive, and environmental stressors. These include cyberbullying and exploitation, commercial surveillance and privacy harms, technoference and digital neglect, identity distortion, exposure to harmful content, ideological manipulation, and displacement of physical play and nature engagement. Developed through an integrative synthesis of multidisciplinary evidence, the ADCEs framework delineates mechanisms through which digital and AI-mediated systems may influence neurocognitive, socioemotional, and ethical development. A structured research and clinical rubric is proposed to support psychometric validation, longitudinal tracking, and cross-cultural adaptation. By integrating developmental science, digital ethics, and public

health, the ADCEs framework provides a coherent scaffold for research, screening, and intervention, enabling policymakers, educators, and clinicians to safeguard children's well-being and agency across convergent physical–digital ecologies.

Keywords: adverse digital childhood experiences; cyberbullying; digital addiction; technoference; online sexual exploitation; AI-mediated influence; human agency; child neurodevelopment; developmental screening rubric; digital policy

The Digital Imperative for a New Adversity Framework

The landmark Adverse Childhood Experiences (ACEs) study revealed the enduring impact of early-life adversity on health and psychosocial outcomes (Felitti et al., 1998). Yet traditional ACEs frameworks do not capture digitally mediated harms—persistent, amplified, and transnational risks including cyberbullying, sexual exploitation, and AI-driven constraints on agency—that shape attention, social learning, identity, and ethical reasoning from the earliest years (Federal Trade Commission, 2023; Felitti et al., 1998; WeProtect Global Alliance, 2023; Zhu et al., 2021). Artificial intelligence further intensifies these risks, influencing children's agency, decision-making, self-concept, and moral reasoning (Livingstone & Smith, 2014; Soriano-Molina et al., 2025).

The Adverse Digital Childhood Experiences (ADCEs) framework addresses this imperative by organizing digitally mediated adversities into ten empirically grounded domains, integrating developmental neuroscience, behavioral science, digital ethics, and public health. It enables precise measurement of severity, chronicity, and developmental timing, facilitating early identification of at-risk children and guiding targeted educational, clinical, and policy interventions. By uniting analytical precision with accessible expression, the ADCEs framework

uses structured exposition and coherent transitions to convey complex concepts effectively to interdisciplinary audiences, preserving its theoretical depth and integrity (Hartley, 2008; Swales & Feak, 2012). Structured scoring rubrics translate research into ethical, resilient, and developmentally supportive practices while informing child-centered platform design and regulatory safeguards to foster cognitive, socioemotional, and moral flourishing in the digital generation (Livingstone et al., 2018; OECD, 2023).

Objectives of the Study

This study aims to establish an empirically grounded framework for conceptualizing and operationalizing Adverse Digital Childhood Experiences (ADCEs), addressing critical gaps in understanding digitally mediated adversities. It integrates domains such as cyberbullying, online exploitation, technoference, identity distortion, hybrid environmental stressors, and AI-mediated influences on agency into a cohesive, theory-driven model. Drawing on neurodevelopmental, longitudinal behavioral, and cross-cultural policy evidence (Ding et al., 2023; Federal Trade Commission, 2023; Livingstone & Smith, 2014; Soriano-Molina et al., 2025; WeProtect Global Alliance, 2023; Zhu et al., 2021), the framework supports systematic assessment and guides research, clinical, and educational applications. It also informs practical implementation by shaping digital literacy curricula, directing educator professional development, and guiding institutional policies that prioritize child-centered technology use (Livingstone et al., 2018; OECD, 2023). By extending traditional ACE constructs to digitally mediated contexts, ADCEs provides a rigorous, actionable tool for safeguarding developmental integrity across physical–digital ecologies.

Method

Integrative Synthesis Approach and Scope

This study employed a theory-driven integrative synthesis of literature from 2015–2025, including peer-reviewed reviews, empirical studies, and authoritative reports, supplemented by conceptual analyses, to examine digitally mediated childhood adversity across prevalence, neurocognitive and socioemotional development, identity formation, behavioral outcomes, algorithmic exposure, and regulatory strategies.

Inclusion criteria emphasized empirical, longitudinal or cross-sectional studies with validated instruments, neurodevelopmental markers, and cross-cultural relevance; excluded were non-empirical, out-of-range, or non-English language studies. Systematic searches of PubMed, PsycINFO, and Web of Science used Boolean terms such as *digital childhood adversity*, *cyberbullying,* and *algorithmic exposure*. Abstracts were screened and full texts coded using a structured framework capturing design, sample, outcomes, and digital exposure, with critical appraisal of quality and bias to ensure evidentiary robustness.

Evidence was synthesized thematically, integrating quantitative, longitudinal, and qualitative findings to operationalize the ADCEs framework. This approach translates dense theoretical insights into actionable, reproducible guidance for research, clinical assessment, and policy interventions, preserving scientific rigor while supporting practical application (Federal Trade Commission, 2023; Felitti et al., 1998; Livingstone et al., 2018; OECD, 2023; WeProtect Global Alliance, 2023; Zhu et al., 2021).

Results

The ADCEs Framework and Taxonomy of Digital Adversity

Through rigorous synthesis of contemporary peer-reviewed literature, governmental and NGO reports, and empirical studies (2015–2025), the present analysis delineates the Adverse Digital Childhood Experiences (ADCEs) framework, a comprehensive, theory-driven, and empirically anchored paradigm for understanding digitally mediated childhood adversities. Childhood now unfolds within digitally saturated ecosystems where algorithmically mediated technologies shape attention, socioemotional engagement, identity formation, and behavioral trajectories from the earliest years. Traditional ACE constructs, while foundational, insufficiently capture the persistent, distributed, and algorithmically amplified adversities of the digital age (Felitti et al., 1998; Soriano-Molina et al., 2025; WeProtect Global Alliance, 2023).

The ADCEs framework identifies ten distinct but interrelated domains of digital adversity that collectively influence neurocognitive, socioemotional, and identity-developmental processes, and, critically, the cultivation of human agency:

1. **Cyberbullying and Digital Harassment:** Repeated online aggression, doxxing, and shaming, often amplified by virality, associated with measurable distress and trauma-like sequelae (Hinduja & Patchin, 2024; Zhu et al., 2021).
2. **Excessive Screen Exposure and Digital Addiction:** Compulsive, patterned use leading to functional impairment, reward-circuit neuroadaptations, and executive function disruption (Aziz et al., 2021; Ding et al., 2023).
3. **Exposure to Inappropriate or Traumatizing Content:** Unmediated engagement with violent, sexual, or self-harm content producing intrusive thoughts, anxiety, and depressive symptoms (Finkelhor et al., 2015; Shiferaw et al., 2025).

4. **Online Grooming and Sexual Exploitation:** Predatory manipulations through deceptive communications that target children for sexual exploitation **(** WeProtect Global Alliance, 2023; Whittle et al., 2013).
5. **Commercial Exploitation and Surveillance:** Algorithmically driven targeting that manipulates engagement or coerces consumption, often violating child-protection standards (Federal Trade Commission, 2023; World Health Organization, 2022).
6. **Digital Neglect and Technoference:** Caregiver-device-mediated interruptions that compromise attachment, responsiveness, and socioemotional development (McDaniel & Radesky, 2018).
7. **Erosion of Physical Play and Nature Engagement:** Digital substitution for unstructured play undermining motor, social, and cognitive development (Akram & Nasar, 2023; Kuo, 2015).
8. **Identity Distortion and Social Comparison:** Exposure to idealized or curated content fostering body dissatisfaction, inconsistent self-concept, and maladaptive social comparison (Avci et al., 2025; Fardouly & Vartanian, 2016).
9. **Family Disruption through Digital Mediation:** Device-mediated communication patterns interfering with parent–child interactions, increasing conflict and emotional withdrawal (McDaniel et al., 2024).
10. **Digital Radicalization and Ideological Manipulation:** Algorithmically reinforced exposure to extremist or coercive ideologies influencing beliefs and behaviors (Akram & Nasar, 2023; Gill et al., 2017).

Evidence underscores the urgency of educational engagement, with cyberbullying affecting 20–35% of adolescents across multiple countries, highlighting the critical need for school-based interventions and comprehensive digital literacy programs (Hinduja & Patchin, 2024; Zhu et al., 202). For example, in middle-school digital literacy programs, structured modules on cyberbullying enable students to identify, report, and mitigate online harassment, operationalizing the *Cyberbullying and Digital Harassment* domain. In high-school media curricula, guided activities on social comparison and online identity help students critically evaluate curated content, illustrating the *Identity Distortion and Social Comparison* domain. These cases anchor the ADCEs framework in practical educational contexts, translating theoretical constructs into actionable learning experiences (Ambrose et al., 2010; Mayer, 2020). These findings directly guide the development of teacher training, anti-bullying curricula, and evidence-based policies to mitigate digital risks and foster safer learning environments. The integrative synthesis revealed converging evidence that sustained exposure to AI-driven digital systems may constrain children's emerging agency and self-regulatory capacities, with potential implications for ethical reasoning and identity formation (Livingstone et al., 2018; Soriano-Molina et al., 2025). Analysis of multidisciplinary studies identified recurring domains of digital adversity—cyberbullying, online exploitation, technoference, and algorithmic manipulation—constituting the empirical foundation for the Adverse Digital Childhood Experiences (ADCEs) framework. Based on these findings, a preliminary research and clinical

rubric was developed to guide psychometric validation, longitudinal assessment, and cross-cultural application. This framework integrates developmental, ethical, and public health evidence to support systematic identification and mitigation of digital risks across hybrid physical–digital contexts.

Conceptual Measurement Model and Scoring Rubric

Rationale and Design Principles

Building on the conceptual legacy of the Adverse Childhood Experiences (ACEs) paradigm, the ADCEs framework posits that cumulative exposure to digitally mediated adversities constitutes a potent predictor of neurocognitive, socioemotional, and identity-developmental outcomes. Unlike traditional ACEs, however, digital exposures are distinguished by their heterogeneous modalities, pervasive chronicity, and algorithmic amplification, necessitating a measurement approach that is both multidimensional and context-sensitive (Livingstone & Smith, 2014; Soriano-Molina et al., 2025; Zhu et al., 2021).

The proposed scoring rubric operationalizes these principles, translating the ten domains of the ADCEs taxonomy into quantifiable indicators that can be evaluated across frequency, intensity, duration, and algorithmic mediation. Indicators include self-reported behavioral and emotional outcomes, platform-level exposure metrics, caregiver and observational assessments, and neurodevelopmental correlates drawn from longitudinal and cross-cultural evidence (Ding et al., 2023; Fardouly & Vartanian, 2016; Federal Trade Commission, 2023).

This operationalization furnishes robust practical utility in educational contexts, guiding classroom screening, school counseling interventions, and systematic monitoring of digital exposure through empirical, objective indicators rather than reliance on subjective judgment

(Livingstone et al., 2018). This research-first instrument is intended for iterative piloting and psychometric refinement, incorporating:

1. Cumulative scoring to capture aggregate digital adversity load;
2. Domain-specific subscales to discern differential impact pathways;
3. Contextual weighting reflecting algorithmic influence and mediation by device, platform, or social network.

By integrating these features, the ADCEs scoring rubric provides a rigorously structured yet adaptable framework for longitudinal research, clinical screening, and policy evaluation, enabling a scientifically robust assessment of digital adversity and its developmental sequelae.

ADCEs Scoring Rubric: Research Pilot and Refined Operationalization

The ADCEs scoring rubric operationalizes the ten-domain framework of Adverse Digital Childhood Experiences, providing a structured tool for quantifying exposure to digitally mediated adversities. The rubric is designed for iterative piloting and psychometric refinement, balancing feasibility with sensitivity to developmental, chronicity, and algorithmic dimensions of digital risk. To optimize accessibility for educational practitioners and policymakers, the rubric articulates precise operational definitions for each domain, reinforced by concrete, evidence-based indicators from empirical studies, enabling seamless application without requiring specialized technical expertise (DeVellis & Thorpe, 2022; Livingstone et al., 2018).

Table 1

ADCEs Domains, Operational Examples, and Initial Indicator Set

Domain	**Short definition**	**Example indicators (for instrument development)**
Cyberbullying	Repeated online harassment	≥2 verified harassment incidents in past 12 months; self-report of ongoing threats

Domain	Short definition	Example indicators (for instrument development)
Digital addiction	Compulsive digital use causing impairment	Scores above clinical cutoff on PSU or IGD scales; school impairment
Traumatizing content	Repeated exposure to violent/sexual/self-harm content	Self-reported distress; platform logs showing repeat exposures
Grooming/Exploitation	Predatory sexual engagement online	Reported contact with adult solicitors; sextortion incidents
Commercial exploitation	Targeted manipulative advertising	Evidence of age-targeted ads/promotions; in-app purchases coerced
Digital neglect	Caregiver device intrusion into caregiving	Observational/parent-report technoference scales
Play erosion	Loss of unstructured physical play	Hours/week outdoors < recommended; motor delays
Identity distortion	Harm from social comparison	Elevated social comparison and body image disturbance scales
Family disruption	Device-driven family conflict	Parent/child conflict scale associated with device usage
Radicalization	Exposure to extremist content	Content exposure reports; ideational change indices

Version 1: Binary Pilot Scoring (Field Feasibility)

The binary pilot scoring approach is designed to enable rapid, reproducible field assessments of Adverse Digital Childhood Experiences (ADCEs) across the ten identified domains. Each domain is scored dichotomously based on empirically defined indicators, with 0 representing absence of exposure within the defined timeframe and 1 indicating verified or self-reported exposure. The cumulative score ranges from 0 to 10, with provisional stratification for pilot use designating 0–1 as minimal digital adversity, 2–3 as moderate, 4–6 as high, and 7–10 as severe, thereby providing an accessible, preliminary tool for identifying children at varying levels of digital risk.

Version 2: Weighted Refined Scoring (Post-Pilot Psychometric Adjustment)

The weighted refined scoring system advances the pilot model by incorporating severity, chronicity, developmental timing, and algorithmic mediation to capture nuanced exposure. Severity weights assign higher values to domains with greater developmental impact (e.g., online grooming = 3; single non-traumatizing exposure = 1), while chronicity adjusts for frequency and duration (e.g., repeated cyberbullying = +2; isolated instance = +1). Developmental timing weights prioritize sensitive neurodevelopmental windows (e.g., early adolescence = +1), and algorithmic mediation modifiers account for exposures amplified by AI or recommendation systems (+1), reflecting systemic influence. The cumulative weighted score ranges from 0 to 30, with provisional research-use stratification designating 0–3 as minimal, 4–7 as moderate, 8–15 as high, and 16+ as severe, providing a psychometrically informed instrument capable of guiding longitudinal research, intervention planning, and policy translation. Weighted scoring affords practitioners nuanced precision by reflecting both the presence and developmental impact of digital adversities, thereby guiding targeted digital literacy interventions, strategic resource allocation for at-risk students, and evidence-informed policymaking (Livingstone et al., 2018; OECD, 2023).

Discussion

Developmental Timing, Mechanisms, and Hypothesized Outcomes

The developmental impact of Adverse Digital Childhood Experiences (ADCEs) depends critically on timing within neurobehavioral and socioemotional maturation. Early childhood exposures, particularly caregiver-related technoference, may impair attachment and self-regulation, predisposing to later socioemotional difficulties (Kuo, 2015; McDaniel & Coyne,

2016). Adolescent exposures more profoundly affect identity formation, peer affiliation, and ethical reasoning, heightening susceptibility to algorithmic manipulation, social comparison, and digital radicalization (Avci et al.,, 2025; Fardouly & Vartanian, 2016). Recognition of these sensitive windows enables educators and counselors to align digital literacy and prevention strategies with neurodevelopmental trajectories (Livingstone et al., 2018; OECD, 2023).

Hypothesized Mechanistic Pathways and Outcomes

Adverse Digital Childhood Experiences (ADCEs) are posited to affect development through cumulative, relational, and algorithmic mechanisms. Cumulative burden of digital adversities correlates with heightened internalizing and externalizing symptoms, reflecting additive neurocognitive and socioemotional effects beyond traditional ACEs. Technoference-mediated attachment disruption during early caregiving impairs emotional attunement and self-regulation, increasing vulnerability to later maladaptation. Algorithmically amplified risks in adolescence reinforce reward-sensitive neural circuits, promote compulsive digital engagement, and weaken critical reasoning and digital literacy. These interlocking mechanisms delineate empirically targetable domains for educational and policy interventions, including school-based digital behavior monitoring, integration of media literacy curricula, and psychoeducational training for teachers and caregivers (Livingstone et al., 2018; OECD, 2023). Collectively, they illuminate how timing, context, and cumulative exposure shape developmental outcomes, underscoring the need for temporally nuanced, evidence-informed prevention and resilience-building strategies across the childhood–adolescent continuum.

Digital Adversity and Developmental Disruption

The proliferation of digital technologies has introduced novel adversities that intersect with traditional stressors, demanding an expanded framework for developmental risk assessment.

Parallel to the seminal ACEs model (Felitti et al., 1998), the Adverse Digital Childhood Experiences (ADCEs) framework posits that cumulative digital exposures—cyberbullying, online exploitation, and digital addiction—can disrupt neurodevelopmental trajectories. Empirical evidence links excessive digital engagement to communication and problem-solving delays in early childhood (Mallawaarachchi et al., 2024) and to cortical, striatal, and cerebellar alterations underlying emotion and cognition (Nivins et al., 2024). Evidence-based interventions, including structured digital monitoring, socioemotional learning programs, and developmental literacy curricula, mitigate risks across ADCEs domains, guiding educators in designing balanced screen-time policies, integrating offline learning, and fostering digital resilience in educational contexts (Livingstone et al., 2018; OECD, 2023).

Neurodevelopmental Implications

Digital adversities affect neurodevelopment by engaging reward and executive function systems in ways distinct from traditional stressors. Screen time has been linked to reductions in cortical surface area and subcortical alterations, impacting learning and emotional processing (Nivins et al., 2024), and associated behavioral outcomes such as increased impulsivity and cognitive inflexibility correlate with exposure duration (Cambridge Judge Business School, 2024). Integrating this evidence, the ADCEs framework guides educators and school mental health professionals in structuring screen-time policies, promoting balanced cognitive engagement, and delivering targeted interventions to mitigate adverse neurocognitive impacts (Livingstone et al., 2018; OECD, 2023).

Socioemotional and Identity Development

Digital technologies in education are not neutral tools; their effects depend on institutional context, pedagogical design, and the social and political values embedded within

them (Selwyn, 2021). Digital environments shape socioemotional development and identity by exposing children to idealized content and cyberbullying, fostering distorted self-concept and maladaptive social comparisons (Fardouly & Vartanian, 2016). These experiences increase anxiety, depression, and body dissatisfaction, particularly among adolescents sensitive to peer influence and online validation (Avci et al., 2025). Additionally, reduced face-to-face interaction linked to digital mediation weakens family bonds and heightens emotional withdrawal (McDaniel et al., 2024). Educators can mitigate these effects through socioemotional learning, psychoeducation on online peer dynamics, and the creation of safe digital environments (Livingstone et al., 2018; OECD, 2023).

Policy and Clinical Implications

The ADCEs framework informs professional development, curriculum design, and digital citizenship initiatives, guiding educators in embedding evidence-based strategies for online safety and ethical technology use. It also supports institutional policy by providing structured indicators for monitoring digital risks and designing interventions that promote resilience, agency, and responsible engagement across school and higher education contexts (Erstad & Voogt, 2018; Redecker, 2017; Selwyn, 2021). The ADCEs framework provides an evidence-based scaffold for clinical practice and policy, guiding strategies to mitigate developmental risks from pervasive digital technologies. Clinically, it enables systematic assessment across ten domains, early identification of at-risk youth, and tailored interventions, including referral pathways for severe exposures such as online grooming, sextortion, or chronic cyberbullying (Berthon et al., 2019; WeProtect Global Alliance, 2023). Policy applications empower schools and higher education institutions to integrate digital literacy, monitor online risks, train educators, ensure algorithmic transparency, and enforce safety measures, using empirically

derived indicators and scoring rubrics to inform interventions and resilience-building curricula (Federal Trade Commission, 2023; Livingstone et al.; 2018; OECD, 2023; World Health Organization, 2022). By linking clinical, policy, and technological domains, the framework promotes resilience, autonomy, and healthy developmental trajectories for the next generation.

Ethical, Legal, and Practical Considerations

Implementing ADCEs requires rigorous ethical oversight, legal compliance, and equity-focused safeguards to protect children in digital environments. Essential measures include robust informed consent, strict data minimization, and secure governance, alongside differentiation between normative developmental responses and clinically significant impairment (Federal Trade Commission, 2023). Engagement with technology platforms is critical to mitigate AI-generated CSAM and algorithmic harms while fostering safe digital ecosystems (The Guardian View on Digital Media, 2024). Ethical implementation for educators and policymakers involves evidence-based digital safety measures that uphold equity, ensure access to digital literacy resources, and safeguard privacy while monitoring online adversities (Livingstone et al., 2018; OECD, 2023). By integrating these imperatives, the ADCEs framework ensures research and interventions are responsible, culturally sensitive, and promote child well-being in complex digital landscapes.

Validation and Future Research Considerations

Establishing the rigor and translational relevance of the ADCEs framework requires a multi-modal validation strategy, including psychometric refinement through multi-item scales, confirmatory factor analysis, reliability testing, and item response theory modeling. Longitudinal cohort studies integrating self-report, caregiver-report, observational, and device-level data will assess predictive validity for neurocognitive, behavioral, and socioemotional outcomes while

mitigating bias. Future research should evaluate implementation in educational and policy contexts, including digital literacy program efficacy, intervention outcomes for at-risk students, and evidence-based guidelines for screen time, monitoring, and AI integration (Livingstone et al., 2018; OECD, 2023). Linking digital adversities to neurodevelopmental markers via cognitive testing, neuroimaging, and cross-cultural analyses, alongside intervention trials and policy evaluations, will translate evidence into actionable strategies that safeguard child development and foster resilience in the digital era.

Limitations

Although the ADCEs framework presents a rigorous multidisciplinary model, it remains primarily theoretical, with empirical validation in progress. Its preliminary scoring system may oversimplify the complexity of digital exposures, and resilience factors are not yet fully incorporated. Broader synthesis of developmental, neurocognitive, and ethical evidence is needed to enhance predictive accuracy. Implementation also faces variability in infrastructure, expertise, and resources, requiring pilot studies to test feasibility, scalability, and equity (Livingstone et al., 2018; OECD, 2023). Continued longitudinal validation will ensure ADCEs remains a robust, actionable tool for guiding interventions and policy in hybrid digital–physical childhood contexts.

Conclusion

The ADCEs framework reconceptualizes childhood adversity for the digital era, capturing algorithmically mediated harms from cyberbullying to AI-driven constraints on agency

while integrating developmental neuroscience, behavioral science, and digital ethics. It enables precise measurement of severity, chronicity, and developmental timing, facilitating early identification of at-risk children and guiding targeted educational, clinical, and policy interventions. By embedding empirically grounded indicators and scoring rubrics, the framework translates research into ethical, resilient practices and informs child-centered platform design and regulatory safeguards that support the cognitive, socioemotional, and ethical flourishing of the digital generation (Livingstone et al., 2018; OECD, 2023).

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