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Review

Neurodevelopmental Consequences of Adverse Childhood Experiences: A Review of Evidence-Based School and Family Interventions

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Abstract

Adverse childhood experiences (ACEs), including abuse, neglect, and household dysfunction, can disrupt children's neurological, psychological, and social development, increasing risks of mental illness, academic difficulties, and chronic health conditions. This review examines the neurodevelopmental consequences of ACEs and evaluates three interventions: trauma-informed schools, School-Based Health Centers (SBHCs), and the Triple P (Positive Parenting Program). Trauma-informed schools aim to improve emotional safety and educator responses to trauma-related behaviors, while SBHCs increase access to medical and mental health services and provide opportunities for earlier identification of trauma-related concerns. Triple P strengthens parenting practices, reduces family conflict, and promotes supportive home environments. Despite their potential benefits, these interventions face limitations involving funding, workforce capacity, family engagement, implementation, and broader social determinants. Because ACEs arise from interconnected individual, family, and community factors, coordinated approaches integrating educational, healthcare, and family-centered supports may offer the greatest potential to promote resilience and improve long-term developmental outcomes.

Keywords: Adverse childhood experiences (ACEs); neurodevelopment; childhood trauma; trauma-informed schools; School-Based Health Centers (SBHCs); Triple P; early intervention; child mental health

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1. Introduction

A major developmental challenge facing children is exposure to adverse childhood experiences (ACEs), particularly because of their potential effects on neurological and psychological development. Conventional ACE frameworks commonly include abuse, neglect, and household dysfunction. Abuse includes physical, emotional, and sexual maltreatment, while neglect refers to failures to meet a child's physical or emotional needs. Household dysfunction can include parental substance use, mental illness, domestic violence, incarceration of a family member, divorce, or severe financial

instability (Neelam, 2024). However, contemporary neurodevelopmental research cautions against treating all forms of adversity as biologically equivalent. The dimensional model of adversity distinguishes experiences involving threat, such as violence and abuse, from experiences involving deprivation, characterized by the absence of expected cognitive, social, or emotional input (Sheridan & McLaughlin, 2014). Threat exposure has been linked particularly to alterations in fear learning, salience processing, and emotional reactivity, whereas deprivation may more strongly affect cognitive and executive development through reduced environmental input. These pathways can overlap, and many children experience both dimensions simultaneously; therefore, neurodevelopmental consequences should be understood as heterogeneous rather than as a uniform 'ACE effect' (McLaughlin et al., 2019).

Children most affected by this problem live in poverty, unstable households, or in unsafe communities that expose them to violence and substance use. Unfortunately, however, children from marginalized racial communities seem to disproportionately experience ACEs but also have limited resources to support them (Tan et al., 2024). These groups are the most vulnerable because they are likely to experience chronic stressors repeatedly. Especially due to family financial hardships, there are food insecurities, housing instability, and parental stress that increases likelihood of traumatic experiences. To further exacerbate the problem, the schools in these underserved communities also lack mental health support systems, making it even more difficult for children to receive intervention or support (Kataoka et al., 2018).

A broader public health understanding of childhood adversity is also reflected in the expanded ACEs framework, which extends beyond adversity occurring inside the household. Research with low-income urban youth has identified community violence, bullying, economic hardship, discrimination, neighborhood danger, and other community-level stressors as important adverse experiences that may be missed by conventional ACE inventories (Wade et al., 2014). This distinction is especially important for children from historically marginalized communities because systemic racism and discrimination can function as chronic stress exposures rather than merely background demographic variables. Community violence and unsafe neighborhood conditions can likewise repeatedly activate physiological stress-response systems even when the child's home environment is comparatively stable. Accordingly, an expanded framework situates childhood adversity across household, school, neighborhood, and structural contexts and avoids placing the full explanatory burden on individual families.

This challenge is considered a major developmental problem because ACEs affect children's lives across many different areas, including emotional, cognitive, behavioral, and academic. For instance, trauma exposure has been linked to increased risk of anxiety, depression, PTSD, substance use, and difficulty forming healthy social relationships later in life (Hakamata et al., 2022). Looking long-term, research has found that childhood adversity leaves neural "embeddings" that persist well into adulthood and impacts the physical health outcomes (Gehred et al., 2021). Moreover, these developmental disruptions can contribute to performing worse in schools, as well as acting out in schools, leading to social problems. Kids that grow up in such environments tend to have low educational attainment, causing higher chances of unemployment throughout life. Adding on, children in such environments also are at higher risk of developing chronic illnesses due to dysregulated nervous and hormone systems by being exposed to high stressful events at an early age. Specifically, this is due to the body being in "fight-or-flight" state over prolonged periods of time, increasing vulnerability to mental and physical illnesses later in life. ACEs also affect the immune and cardiovascular systems since long-term stress increases inflammation throughout the body and dysregulates immune functioning, which can lead to heart disease, diabetes, and hypertension in adulthood (Gehred et al., 2021). Hence, ACEs are not only an individual's issues but also a public health concern that needs to be addressed.

There are numerous factors that contribute to the prevalence of ACEs, ranging from family instability, domestic violence, parent's mental health, substance abuse, neglect, and abuse. Looking broader, there are community factors such as neighborhood safety, poverty, discrimination, and access to healthcare and educational resources that can further exacerbate this issue (Tan et al., 2024). Together, these create an unsafe, unpredictable, and emotionally distressing environment for kids. For example, parental substance abuse or untreated mental health can impair their ability to provide consistent support and care, which also increases the risk of neglect and emotional abuse. Similarly, family instability can create feelings of insecurity and uncertainty during critical periods of development. To further exacerbate the issue, children living in impoverished neighborhoods may experience housing instability and be exposed to community violence, all of which increase the likelihood of adverse experiences. In regard to educational resources, children who suffer from ACES are more likely to live in neighborhoods that are underfunded and under-resourced, resulting in teachers and other officials to be unaware on how to better support the students (Morton & Berardi, 2017). As a result, children experiencing adversity may not receive the appropriate interventions necessary to support their development.

The impact of ACEs on children and families affects developmental, psychological, social, and economic outcomes. Developmentally, trauma can impair cognitive functioning and emotional regulation due to prolonged exposure to stress that impairs the prefrontal cortex from developing appropriately (Goodpaster et al., 2025). This also leads to many problems in schools with children struggling academically, displaying behavioral problems, and experiencing social delays. Psychologically, ACEs is strongly associated with self-harm and substance use disorders later in life (Hakamata et al., 2022). Socially, trauma also interferes with relationship building, trust, and communication, leading to trouble with maintaining peer relationships down the line. Economically, untreated childhood trauma can contribute to lower educational achievement and employment instability in adulthood, perpetuating cycles of poverty. Hence, addressing ACEs and specifically helping children in such situations should be a top priority.

2. Challenges

One of the greatest challenges in addressing ACEs is that many adverse experiences occur within children's homes, whether that is abuse, domestic violence or parental mental illness. Unlike many other challenges that can be easily spotted and addressed through schools or healthcare systems, ACEs are often rooted in family environments that professionals have limited ability to change. Even if children receive support at school, they may have to return to the same stressful conditions that contributed to their trauma in the first place, making it increasingly difficult to address the root cause of the issue.

Another major challenge is that ACEs frequently go unnoticed because children may be unwilling or unable to disclose their experiences. This can come from feelings of fear of potentially losing their parents or lack of awareness that their experiences are abnormal, preventing many children from seeking help that they really need. Additionally, signs of trauma may present as behavioral problems, academic struggles, or social withdrawal, making it difficult for parents, educators, and healthcare providers to accurately identify the children that need proper intervention.

Lastly, many communities, particularly low-income and rural areas, face shortages of mental health professionals, school counselors, and social workers. Even when children are identified as needing support, families may encounter financial barriers, long waitlists, or lack of insurance coverage to truly get the appropriate services. These barriers further delay intervention and lead the effects of the trauma to worse over time. Together, these challenges demonstrate that ACEs are not solely individual or family

problems, but complex developmental and public health issues influenced by a plethora of factors. Hence, effectively addressing ACEs requires coordinated efforts among schools, healthcare providers, and policymakers to protect these children and provide them a brighter future.

3. Methods

This narrative review synthesized peer-reviewed research and policy literature concerning the neurodevelopmental consequences of adverse childhood experiences and interventions operating at school and family levels. Literature was identified through targeted searches of PubMed and Google Scholar, supplemented by reference-list searching of relevant reviews and intervention studies. Search concepts included combinations of terms related to "adverse childhood experiences," "childhood adversity," "threat," "deprivation," "neurodevelopment," "trauma-informed schools," "school-based health centers," "Triple P," "expanded ACEs," "community violence," and "discrimination." Priority was given to peer-reviewed systematic reviews, meta-analyses, longitudinal or population-based studies, intervention evaluations, and recent studies published primarily from 2017 through 2026, while older foundational studies were retained when necessary to define major frameworks or document longstanding methodological concerns. Studies were included when they examined children or adolescents, neurobiological or developmental consequences of adversity, educational or health outcomes relevant to ACEs, or the implementation and effectiveness of one of the three focal interventions. Sources were excluded when they were unrelated to childhood adversity, did not address developmental, health, educational, or intervention outcomes, or lacked sufficient relevance to the review's school- and family-centered scope. Policy documents were included when necessary to describe specific initiatives, such as the New York City TACTIC Act. Because the goal was interpretive synthesis rather than exhaustive effect estimation, study findings were organized narratively around neurodevelopmental mechanisms, intervention benefits, implementation limitations, equity considerations, and gaps in causal evidence. The three interventions were selected to represent complementary levels of action: school climate and educator response, school-based healthcare access, and family-level prevention.

4. Solution 1: Trauma-Informed Schools

One of the most widely implemented approaches to addressing ACEs is implementing trauma-informed schools. Essentially, these systems are designed to help educators and other school professionals recognize the behavioral, emotional, and academic difficulties displayed by students that may stem from underlying trauma rather than intentional misconduct. Instead of solely relying on disciplinary measures, trauma-informed schools seek to create a supportive environment that prioritizes emotional safety, trust, and building positive relationships between students and educators (Morton & Berardi, 2017). This is accomplished through staff training on trauma awareness, increased access to mental health resources, and utilizing restorative discipline practices.

An example of a trauma-informed school initiative is the The New York City Training and Comprehension of Trauma in Children (TACTIC) Act. It was introduced to establish trauma-informed practices within New York City Schools, specifically with providing training for teachers and school staff so that they can better recognize signs of trauma in students and respond accordingly. Moreover, the policy also proposes the creation of a TACTIC Council to coordinate educational support for trauma-informed care (State of New York). With this policy, New York aims to improve identification of trauma amongst children in schools, support emotional needs of students, promote

connection between children, educators, and behavioral health professionals, and overall, improve the long term mental health outcomes for children.

Although the act has not undergone any evaluation, research on trauma -informed schools support that these approaches do reflect on student outcomes. For instance, a study has found that trauma-informed schools reduce behavioral problems, improve emotional regulation, and create safer school environments (De Stigter et al., 2024). Moreover, trauma-informed educational practices have been associated with strengthening student-teacher relationships, which is reflected on improving academic engagement and achievement (Wassink-de Stigter et al., 2024). These findings directly support the goals of the TACTIC Act because it shows how trauma-informed interventions can improve developmental outcomes. Since childhood trauma disrupts emotional regulation and stress response systems, trauma-informed school environments aim to reduce chronic stress while increasing emotional safety for students (McLaughlin et al., 2019). Looking beyond that, training teachers to recognize trauma-related behaviors can help them proceed with appropriate actions rather than making children undergo disciplinary practices that could do more harm than good; this includes creating an emotional distance between students and faculty due to mistrust in the system. Moreover, these punitive actions do not inhibit those behaviors, but instead, may intensify emotional distress and reinforce feelings of fear and isolation among students affected by trauma. By implementing trauma informed approaches, the TACTIC Act encourages schools to focus on the root cause of such behaviors and create supportive interventions rather than punishment-centered responses. Because ACEs can disrupt neurological development, many students affected by trauma struggle with impulse control, emotional regulation, and stress management, which may manifest as behavioral problems in the classroom. Therefore, trauma informed systems can help create healthier coping mechanisms since it prioritizes students' well-being to create an environment that supports positive long-term development. Hence, this policy will achieve its intended goals if it continues to have consistent funding and access to mental health resources.

However, there is an unintended consequence of teachers feeling overburdened with becoming responsible for addressing complex mental health issues without proper support. While trauma-informed training can be beneficial with educators being able to recognize trauma-related behaviors, teachers are not licensed mental health professionals and may struggle to respond to these concerns. This can also contribute to burnout and emotional exhaustion, especially in underfunded schools where counselors and mental health professionals are limited. Additionally, teachers' primary responsibility is educating children, and giving them this added responsibility may shift away from the academic aspect of schools. Thus, without adequate funding and a proper staff, implementing TACTIC in schools could limit the overall effectiveness and quality of trauma-informed care that students receive.

Beyond teacher burden, trauma-informed approaches also carry the risk of unintentionally reinforcing a deficit-based understanding of students, particularly those from marginalized or low-income communities. When behaviors such as withdrawal, emotional dysregulation, disengagement, or classroom disruption are interpreted primarily through the lens of trauma, educators may begin to view students according to presumed psychological deficits rather than considering their individual strengths, resilience, cultural backgrounds, and the broader structural conditions shaping their experiences. Critical scholarship on trauma-informed education has therefore cautioned that even well-intentioned approaches may contribute to the over-pathologization of students when adversity becomes the primary framework through which their behavior and identity are understood (Winninghoff, 2020; Watson & Astor, 2025). This concern may be especially important for students who already experience inequities related to poverty, race, neighborhood violence, or unequal disciplinary practices. Consequently,

trauma-informed schools should not simply teach educators to identify signs of trauma; these practices should be integrated with culturally responsive, strengths-based, and equity-oriented approaches that recognize students' agency and resilience while also acknowledging the structural conditions that contribute to adversity.

5. Solution 2: School-Based Health Centers

Another approach to addressing ACEs is the implementation of School-Based Health Centers (SBHCs), which are healthcare facilities located within schools that provide students with access to medical, mental health, and behavioral health services. Since children spend a significant portion of their time in schools, SBHCs can help reduce barriers that often prevent children from receiving appropriate care, including transportation difficulties and financial limitations. These centers may be particularly valuable for children who have experienced ACEs because they provide an accessible setting in which trauma-related concerns can potentially be identified and addressed earlier. However, the ability of SBHCs to achieve effective ACE screening and early intervention depends heavily on successful implementation. A study identified significant barriers to ACE screening within school-based health settings, suggesting that simply having these services available does not guarantee that trauma will be consistently identified or appropriately addressed (Tsevat et al., 2025). Therefore, the effectiveness of SBHCs in preventing trauma-related concerns from progressing into more serious developmental problems depends not only on accessibility, but also on the screening procedures, resources, staff capacity, and follow-up systems available within individual programs.

The effectiveness of SBHCs is largely attributed to their ability to provide accessible and timely mental health services. Research has found that school-based health centers improve access to mental healthcare, increase utilization of counseling services and reduce unmet menthol health needs among adolescents (Love et al., 2019). Because ACEs are associated with increased risks of anxiety, depression, and emotional dysregulation, having mental health professionals readily available within schools allows students to get support in an accessible environment. Moreover, as previously discussed, chronic exposure to stress during early childhood dysregulates immune, endocrine, and cardiovascular functioning, increasing vulnerability to conditions such as asthma, obesity, and other chronic illnesses later in life (Gehred et al., 2021). This is how SBHCs can intervene by having routine health screenings and providing early intervention services, allowing them to identify and address health concerns before they become more severe. Research has actually demonstrated that SBHCs have contributed to reductions in emergency department visits related to asthma and have successfully supported obesity prevention (Itriyeva, 2024; Coble & McDaniel, 2023) . Beyond just physical health, SBHCs also contribute to educational success; students have found that students who utilize SBHC service demonstrate improved school performance, high grades, and increased likelihood of high school completion (Zhang et al., 2025). These findings are especially relevant for children who experience ACEs because trauma often contributes to chronic absenteeism, academic difficulties, and behavioral challenges. By reducing barriers to healthcare and providing adequate support to mitigate emotional stressors that interfere with learning, SBHCs can help promote academic achievement and prevent possible developmental challenges associated with childhood adversities.

Despite these benefits, several challenges limit the effectiveness of SBHCs. One major limitation is funding, especially since establishing and maintaining comprehensive health centers within schools require substantial financial investment and hiring trained healthcare professionals. As a result, many schools, particularly those located in low-income communities, may lack the resources necessary to implement or sustain these programs. This can create disparities in access to care, leaving some of the most vulnerable children that are exposed to ACEs without adequate support.

Additionally, while SBHCs can help identify and treat the consequences of childhood adversity through screening, counseling, and preventative care, they cannot directly eliminate the underlying causes of ACEs. Children do spend most of their time in schools, but, at the end of the day, they return back to the same homes that gave them the trauma in the first place, whether that is abuse, poverty, or neglect. Therefore, SBHCs may be effective in reducing the impact of trauma by ensuring that it does not compound into future developmental or medical problems, but they are less effective at preventing the occurrence of ACEs themselves. Lastly, some families may be hesitant to utilize school-based health service due to concerns surrounding privacy, stigma related to mental health treatment, or distrust of healthcare systems. These barriers may prevent students from fully benefiting from these incredible available services. While School-Based Health Centers represent a promising strategy for addressing the developmental and health consequences of ACEs, their success depends on adequate funding, proper staffing, and appropriate integration within the community.

6. Solution 3: Triple P (Positive Parenting Program)

While trauma-informed schools and School-Based Health Centers help reduce the impact of ACEs after they occur, another approach focuses on preventing adverse experience from occurring in the first place. One example of this is the Triple P (Positive Parenting Program), a parenting intervention designed to strengthen parenting skills, improve parent-child relationships, and promote positive family environments. Triple P provides varying levels of support from universal parenting education to intensive interventions for families experiencing significant challenges. The program is based on the idea that strengthening parenting practices can reduce many of the family-level risk factors associated with ACEs, including abuse, neglect, and conflict (Sanders, 2023).

Triple P may be particularly effective in addressing ACEs because many of the adverse childhood experiences originate within the home environment. The program teaches parents strategies to create safe and supportive environments, use positive discipline techniques, and effectively manage stress and family conflict. By improving these problem solving skills and promoting self-regulation among all family members, Triple P aims to reduce the likelihood that children will be exposed to chronic stressors that contribute to ACEs. Furthermore, the program emphasizes parental self-care and emotional well-being, recognizing that caregivers' mental health significantly influences child development and family functioning (Sanders, 2023). What makes this program even more effective is that it is designed to be population-level intervention that involves psychologists, social workers, and family support specialists to help promote positive behavior and reduce family conflict. Additionally, research has demonstrated positive outcomes associated with Triple P participation with studies showing that the program improves parenting practices, increases self-efficacy, reduces parenting stress, and decreases emotional and behavioral problems among children (Li et al., 2021). By equipping parents with positive techniques in terms of communication and stress-management, Triple P helps create a more stable and supportive home environment that reduces children's exposure to chronic stress and adversity. Thus, Triple P not only addresses existing family challenges but may also help prevent adverse childhood experiences from occurring in the first place by strengthening familial relationships.

Despite these benefits, there are still some limitations associated with Triple P. The program relies heavily on parent participation and engagement. That means that families experiencing severe stressors such as substance abuse, domestic violence, untreated mental illness, and financial hardship may be less likely to enroll or complete the program, despite these populations being most at risk for ACEs. Additionally, while Triple P can improve parenting practices and reduce family conflict, it may be difficult for parents to consistently practice these strategies when they are dealing with external stressors simultaneously. Alongside, Triple P primarily targets family-level risk factors

and therefore cannot fully address broader societal contributions to ACEs, such as poverty, community violence, discrimination, and other extraneous factors. These exist outside the scope of parenting interventions and may continue to be exposed to children, leading to children still experiencing chronic stress even when their family situation could have improved. To maximize effectiveness, Triple P should be implemented alongside school based intervention and mental health services to address the multifaceted nature that contributes to ACEs.

7. Conclusion

No single intervention is sufficient to address the complex and multifactorial nature of ACEs. Instead, integrating trauma-informed educational practices, accessible school-based healthcare, and evidence-based parenting programs offers the greatest potential to mitigate the neurodevelopmental consequences of childhood adversity. Future policies should prioritize coordinated, multidisciplinary approaches that combine prevention, early intervention, and sustained community investment to improve developmental trajectories and reduce long-term health inequities among vulnerable children.

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