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Effects of Substances on the Fetus with Disabilities and Implications for Learning Outcomes

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Abstract:

The increasing urgency surrounding the opioid epidemic and other substance-use dynamics necessitates focused attention on how prenatal substance exposure and accompanying fetal disabilities shape children's learning trajectories. This analysis reveals that distinct cohorts of affected children can be identified based on the mix of substances and resulting disabilities, each associated with differential impacts across behavior, cognition, and academic achievement. Given the widespread implications for the population and the mounting demand for targeted initiatives in early-life learning, policymakers, researchers, and practitioners must concentrate efforts on these specific cohorts. To stimulate clarifying research, establishing formalized networks for sharing information, data sources, indicators, and instruments is recommended. Furthermore, fostering broader stakeholder coordination and reinforcing channels to influence general educational policy are essential steps for mobilizing relevant actors and addressing the complex links between prenatal exposure and learning outcomes systematically.

Keywords: *Prenatal Substance Exposure, Learning Trajectories, Fetal Disabilities, Cohort Identification, Educational Policy.*

1. Introduction

Prenatal exposure to substances may have considerable effects on fetal development, along with potential ramifications for learning and educational attainment. Maternal consumption of licit and illicit drugs during pregnancy constitutes a major public health issue, with serious socio-economic implications. Public awareness campaigns seek to inform pregnant women about the risks of substance use on fetal health, and many countries implement pharmacological substitutes during pregnancy to reduce the practice of drug-seeking behaviour. However, learning and developmental outcomes remain poorly studied alongside the more broadly understood neonatal and infant profiles. Learning outcomes are complex, multi-faceted constructs encompassing an individual's broader performance within educational settings, and developmental trajectories in domains such as cognitive, language and motor skills. Disabilities related to learning outcomes serve as crucial indicators of later developmental validity. Such disabilities encompass a range of acquired or congenital conditions associating prenatal exposure with cognitive, linguistic, attention and executive function effects. (Deori, C., Aziz, S., Bordoloi, P., & Das, S., 2024) Ongoing tracking is therefore essential to identify intervention needs and resource allocation. Pharmacological drugs taken during

pregnancy can interfere with the normal unfolding of fetal development. The impact of a given substance is highly context-dependent, with individual biological, genetic, dosage, timing and mixture profiles influencing effects; the challenge of establishing precise, identifiable links between substance exposure and learning outcomes is therefore substantial. Conceptually, four overlapping areas warrant consideration: the nature and types of prenatal substance exposure; the range of corpus conditions applied to the understanding of fetal disabilities and their respective profiles; and the specific scope of learning outcomes under discussion. (Ghosh, R., & Sharma, B., 2022)

1.1. Background and Rationale

Substance exposure during pregnancy endangers fetal health and development and leads to significant educational ramifications. Public health literature elaborates on the types and routes of exposure and the attendant maternal and fetal risks. Environmental insults to fetal development are a relevant topic for the field of education because compromised neurodevelopment affects children's later learning abilities and educational trajectories. In particular, impaired prenatal development is known to precipitate sequelae within the domains of cognition, language, and executive function, all of which constitute significant risk factors for learning disabilities. Conditions such as these are frequently addressed through support frameworks such as individual education plans (IEPs) in alignment with Canada's early learning and childcare policy framework. (Deori, C., Aziz, S., Bordoloi, P., & Das, S., 2024)

Maternal exposure to a variety of substances in utero is implicated in a range of fetal disabilities that could compromise and influence a child's ability to learn, alongside conditions congenital at birth. These disabilities include, among others, fetal alcohol spectrum disorder (FASD), attention-deficit/hyperactivity disorder (ADHD), speech and language impairments or disorders (SPLD), autism spectrum disorder (ASD), and language impairment (LI), all of which exhibit potential for adverse impacts upon later learning outcomes across multiple domains .

1.2. Scope and Definitions

Neurodevelopmental journals define substance exposure in terms of the timing and type of drug action. The key term "substance" refers broadly to any chemical capable of significant neuropharmacological action. Exposure typically implies maternal consumption—for instance, orally (as in food, beverages, or pills), intravenously (via needles, such as in intravenous drug use), intranasally (inhaled through the nose), or via vapor (pregnant women occasionally inhale drugs through the mouth). Four categories of factors determine whether learning-related considerations are warranted. Fetal disabilities of interest include fetal alcohol spectrum disorder, opioid lawsuit pregnancy, maternal smoking, and typical prenatal additional exposures such as lead.

"Learning" means cognitive and academic achievement. Cognitive outcomes include neurodevelopmental and classical school preparedness, literacy, numeracy, attention, memory, and other learning-indexed cognitive skills. Fetal disabilities with these learning-related components, along with congenital disabilities affecting these domains to either moderate or aggravate substance-related deficits, are classified as having implications for learning. Learning outcomes in classical academic subjects—and links to terminology such as school readiness and developmental expectations in early childhood—are therefore focal.

2. Pharmacological Substances and Fetal Development

The edges of possible effects on fetal development depend on three central issues: timing—whether the substance is present during a period of neurodevelopmental vulnerability, dosage—whether the exposure is sufficient to act on a relevant biological target, and mechanism—whether the exposure modulates pathways shown to influence neurobiological development. Although pharmacological substances are primarily searched for their possible teratogenic effects (those producing morphological malformations), other classes of drugs, such as those acting on

neonatal neurotransmitter systems, may create neurochemical changes without being considered teratogenic. The notion of critical windows of vulnerability is an important one in neurodevelopmental research. For example, alcohol exposure during the period of the neural crest may be associated with facial defects but not with other problems, whereas alcohol exposure during later periods is associated with more widespread effects. Examining these cognitive outcomes in each group of childhood neurodevelopmental disabilities may assist in bridging the research from the medical field to the educational sphere, ideally informing the teaching and learning process. (Sahu, P., & Swain, S., 2024)

Prenatal exposure of the developing fetus to specific drugs can lead to the production of congenital disabilities, but exposure to one or various types of central nervous system–active substances may induce an increased risk of neurodevelopmental disabilities. These follow distinct but overlapping neurochemical pathways during the course of development. A subgroup of these neurodevelopmental disabilities is now well known to involve specific changes in cognitive abilities or learning profiles, and research on learning abilities in children presenting these disabilities often describes markedly different trajectories. The frequent co-occurrence of these conditions in the same child suggests that the impact of exposure to other drugs may resemble that of some kinds of congenital disorders, particularly those with associated dysmorphic traits. All these factors may affect attention, memory, speech, language, and executive functions. (Radhakrishnan, S., & Abraham, S., 2024)

2.1. Categories of Substances (e.g., CNS-Active Drugs, Teratogens)

Central nervous system (CNS)-active drugs constitute a large class of pharmacological compounds that can have harmful effects on fetal development. Medications in this category include antidepressants, opioids, antiepileptic drugs, and drugs of abuse such as alcohol, cocaine, and methamphetamine. Exposure to drugs in this class during the second and third trimesters of pregnancy is associated with neurodevelopmental disorders, attention-deficit/hyperactivity disorder (ADHD), autism spectrum disorder (ASD), or potential fetal alcohol spectrum disorder (FASD) (Forray, 2016). Early screening and diagnosis are critical, as a substantial proportion of affected individuals continue to experience learning difficulties throughout their schooling. Although exposure to maternal antidepressant medication during pregnancy does not appear to be a direct teratogen, it may indicate additional co-occurring risks; the content of these prescriptions may also relate to learning and intellectual development. Similarly, the diagnosis of maternal depressive disorders is associated with a doubling of the risk for children developing learning disabilities.

A subset of these substances is both developmentally toxic and teratogenic, causing specific and recognizable congenital conditions, facial features, or other anomalies. This group includes anti-epileptic and chemotherapeutic agents, retinoic acid, thalidomide, and vitamin A in particular doses and formulations. Several widely prescribed medications with well-characterized teratogenic effects are associated with substantial learning and cognitive impacts, but the fewest documented cases support any such association for thalidomide and certain folic acid derivatives. Other drugs with clear association to teratogenic events induce substantial and widespread developmental disruption but lack established, recognized learning effects. These include isotretinoin and methotrexate therapy, which do not appear to directly determine or predict learning or educational outcomes. Sodium valporotate is also widely recognized as an embryotoxic agent with no such established links. Nevertheless, use of the former classes of medicines does frequently indicate additional potential for complex and multifocal influence on education and learning attainment, both directly and indirectly. Such conditions may also themselves relate to etiology, treatment, and outcomes of learning disabilities. (Chaturvedi, P., & Kumar, A. 2021)

3. Fetal Disabilities with Learning Implications

Prenatal substance exposure can cause disabilities with significant lifelong effects. Many maternal substances target the same brain areas fetal and infant learning depend on, such as attention, memory, and social cognition. Exposure to such substances can therefore disrupt the early and critical learning and neurodevelopmental trajectories that shape later learning outcomes and needs. Maternal use of psychoactive substances during pregnancy poses serious public health concerns and is associated with a range of potentially diagnostic fetal disabilities affecting postnatal learning trajectories. Specifically, public education systems may play a role in monitoring and mitigating the neurodevelopmental impact of prenatal substance exposure on learning trajectories. The goal of this survey is to pinpoint which disabilities are associated with learning-relevant influences from widely used psychoactive substances: tobacco, ethanol, cannabis, and other CNS-acting drugs.

The term "substance" in this context comprises pharmacological agents that enter the fetal brain via maternal circulation. Examples of such substances include caffeine, nicotine, illicit drugs, and psychoactive prescription drugs. The focus here is restricted to substances with documented associations to developmental disabilities that predict potentially similar or overlapping effects on learning-relevant domains of cognitions, brain processes, behaviors, or other considered learning outcomes. Specific disabilities and conditions mentioned relate directly to academic competencies included in the learning outcomes framework. (Chaturvedi, P., & Kumar, A., 2021).

3.1. Common Neurodevelopmental Disabilities Associated with Prenatal Exposure

Prenatal exposure to alcohol, drugs, and other substances can lead to a range of neurodevelopmental disabilities. While many people are aware of fetal alcohol spectrum disorders (FASD), exposure to other substances such as nicotine, alcohol, opiates, and drugs from the cannabis or stimulant classes is also associated with substantial risk of cognitive, behavioral, and learning difficulties. Individual disabilities can have overlapping or divergent features, and the presence of congenital disabilities—such as congenital heart conditions or common syndromes—can further complicate evaluation or provision of appropriate support.

Fetal alcohol spectrum disorders, including fetal alcohol syndrome (FAS) and partial fetal alcohol syndrome (PFAS), comprise a spectrum of malformations, neurodevelopmental deficits, and behavioral abnormalities resulting from damage to the central nervous system following maternal consumption of alcohol. Maternal alcohol use during pregnancy is a well-established risk factor for a variety of neurodevelopmental disabilities, including autism spectrum disorder, attention-deficit hyperactivity disorder, and specific language impairment. Research using multiple study designs indicates that prenatal exposure to alcohol interferes with early attention, arousal, language, and motor skills; the functional domains most frequently impacted overlap with the skills essential to academic performance. (Jain, A., & Sharma, P., 2023).

3.2. Impact of Congenital Conditions on Cognitive and Learning Profiles

Congenital disabilities affect a wide range of cognitive processes and learning skills that are critical for school, and are prevalent among children with a history of prenatal substance exposure. The disabilities either directly caused or associated with alcohol or other drug exposure modify the expected cognitive and learning profiles for these individuals, as do additional fetal conditions not tied to substance exposure. Neurodevelopmental disabilities associated with prenatal exposure commonly include fetal alcohol spectrum disorders (FASD), attention-deficit/hyperactivity disorder (ADHD), and autism spectrum disorder (ASD).

Congenital disabilities not known to have neurobiological links to substance exposure but present at birth nevertheless broaden the spectrum of cognitive profiles and consequently the scope of learning needs. These range from genetic anomalies affecting metabolism or growth to childhood-onset epilepsy. Neurodevelopmental disabilities

specifically associated with exposure to alcohol or other drugs are more frequent than genetic syndromes yet remain corner cases among the general population. Other disabilities widely acknowledged to occur alongside alcohol exposure, such as microcephaly, facial dysmorphism, failure to thrive, and organ malformations including commonly regarded teratogenic substances that point toward neurodevelopmental disability. (Prasad, R., & Anjali, K., 2018).

4. Impact of Prenatal Substance Exposure on Learning Outcomes

Many substances may compromise fetal development. Data on their teratogenicity—quantity, critical periods, biological mechanisms helps link exposure to later learning difficulties. Pregnant people also combine multiple substances, yet categories exist: central nervous system CNS active drugs regularly used during gestation, other recognized teratogens, and exposures spanning both groups (Subramoney et al., 2018). Evidence underscores the distinct, often unconscious choice of substances during pregnancy (N. Mattson et al., 2001). Teratogenic risks and concomitant conditions distinguish high-exposure cohorts: prenatal alcohol exposure alone versus tobacco, cannabis, and other drugs, generating diverse neurodevelopmental disabilities. Some disabilities arise from congenital conditions unconnected to teratogens; they may coexist with neurodevelopmental disorders stemming directly from substance effects. Learning outcomes are equally multidimensional. They encompass motor, language, and cognitive development before school entry; academic ability, adaptability, and achievement in literacy and numeracy concurrent with classroom instruction; classroom behaviour and social skills, potentially examined through the learning disability framework; and longer-term trajectories—general learning support, intellectual disability, specific disabilities, or functioning at pre- or post-school levels.

4.1. Motor, Language, and Cognitive Development Trajectories

Motor, language, and cognitive development trajectories are significantly affected by prenatal substance exposure. These trajectories influence classroom performance and overall adjustment. For children prenatally exposed to alcohol, delays in gross and fine motor skills, language, and cognitive development are more pronounced. They are also at greater risk for various attentional, behavioral, social, and emotional problems, and consequently require specific supportive measures. Children with neurodevelopmental disabilities associated with prenatal exposure generally show broad impairments across these domains. Programmes providing additional support in these areas, along with executive function and visual–spatial skills, maintain priority throughout the educational trajectory. (Nayak, R., Murthy, P., Girimaji, S., & Navaneetham, J., 2012)

4.2. Academic Achievement and Educational Trajectories

Academic achievement, particularly in basic literacy and numeracy, is another area in which children with fetal alcohol spectrum disorder (FASD) encounter notable difficulties. Cross-sectional studies tend to find lower standardized test scores for children with confirmed FASD compared to peers without exposur. The underlying neurodevelopmental challenges—deficits in attention, visual-motor integration, and executive function—also shape the educational trajectories of children with a broader category of cumulative risk factors associated with prenatal substance exposure, including psychoactive drugs, poly-substance use, maternal mental health problems, maternal age below 20, and impoverished home environment. Several children with neurodevelopmental disabilities, including those specifically related to prenatal exposure, demonstrate a gradual improvement in academic performance throughout the primary grades, yet most remain vulnerable to schooling difficulties. (Prasad, R., & Anjali, K., 2018)

5. Assessment and Monitoring

1. Prenatal substance exposure is a critical public health concern that can result in fetal disabilities, with important implications for education. An estimated 10–20% of children are born exposed to commonly used drugs

across various contexts in Canada. Such exposure is associated with a range of possible neurodevelopmental outcomes affecting learning, with rates of fetal alcohol spectrum disorder (FASD) particularly high among people who use substances. Fetal alcohol exposure can exacerbate the negative impacts of other conditions, both congenital and acquired. Timely identification of relevant disabilities, assessment of learning impacts, and targeting of educational resources can support successful development and achievement.

2. Diverse fetal disabilities linked to substance exposure can affect teaching and learning trajectories. These conditions are characterized by varying combinations of attention, memory, language, and executive function difficulties, which may be exacerbated by other disorders. Consequently, educational measures, achievement, and access to resources need to be monitored over time. Equally, congenital conditions unrelated to substance use can influence development, mediating the effects of substance exposure.

3. Several widely used frameworks describe the effects of substance exposure on children, but none specifically address the impacts on learning relevant to educational practice. Profiles of neurodevelopmental disabilities categorize the potential consequences of early exposure identified by models such as the US Centers for Disease Control and Prevention's FASD 1-2-3. These include consideration of behavioral difficulties in classroom settings and how other conditions can intensify challenges associated with substance exposure. (Sharma, R., Sharma, S., & Gupta, U. , 2015)

5.1. Prenatal and Postnatal Screening

Several benchmarks exist for assessing exposure during pregnancy and infancy, identifying risk and referral possibilities associated with learning outcomes. Two relevant milestones for monitoring fetal and newborn conditions feature at the 20-week ultrasound and the newborn check-up within the first two weeks post-partum. Multiple biomarkers can indicate increased learning risk and facilitate timely intervention referrals.

In particular, the 20-week ultrasound can assist in detecting some fetal alcohol spectrum disorders (FASDs), even through three-dimensional modalities. Abnormalities consistently observed in this disorder include distinctive facial morphologies (smooth philtrum, thin upper lip, small palpebral fissures, midface hypoplasia), other craniofacial anomalies (microcephaly, neural tube and thoracoabdominal defects, genitourinary malformations), and congenital heart conditions. Furthermore, prenatal exposure to significant psychotropic substances increases the hazard of atypical head growth at birth. Head circumference hinders the evolution of diverse organ systems and therefore the overall growth of children from the fetal period. Typical values for head growth still often lie within the normal range, which highlights the need for post-natal neurodevelopmental screening equipped with suitable neurodevelopmental assessments following the standard EEAC (Early Education Assessment Checklist) framework. (Prasad, R., & Anjali, K., 2018).

5.2. Neurodevelopmental Assessments and Learning Difficulties Identification

Neurodevelopmental assessments are essential for identifying children at risk of learning difficulties associated with prenatal substance exposure. These assessments are particularly important for children with congenital disabilities, which may be present at birth or develop during infancy. Teratogenic mechanisms can affect various aspects of fetal development, and the specific neurodevelopmental disabilities and congenital conditions that result from prenatal substance exposure modulate cognitive and learning profiles. Neurodevelopmental assessments should be conducted as early as possible and aligned with maternal and fetal indicators of risk. Timely identification of potential learning difficulties facilitates the implementation of appropriate interventions, yet an urgent need remains for robust longitudinal data linking early neurodevelopmental profiles to later learning outcomes.

6. Interventions and Educational Strategies

Certain longitudinal studies of developmental trajectories and academic outcomes suggest more nuanced educational approaches may be required, and evidence-based recommendations identifying suitable interventions and pedagogical practices have been proposed. Although the potential for neurobiological, cognitive, and academic targets influencing a child's response to instruction develops during early childhood, many schools are not currently equipped to address the resulting learning needs. Consequently, the provision of timely support to students in at-risk categories, within their critical period for learning language and literacy, remains paramount. A slight reconsideration of the roles of early intervention and individualized education plans in the broader early education context enables systematic alignment with evidence supporting early-age specialized treatment via devices such as hearing aids for these groups. Similarly, recent syntheses of all the remaining associated empirical findings point to their solution-specific importance in narrowing down the most appropriate individual evidence-based teaching approaches. These comprise the most suitable high-leverage practices in the general education classroom, major classroom environmental factors associated with enhanced learning, and low-cost assistive technology solutions. (Nayak, R., Murthy, P., Girimaji, S., & Navaneetham, J. 2012).

6.1. Early Intervention and Individualized Education Plans

Prenatal and postnatal substance exposure—including maternal alcohol and tobacco use, use of illicit drugs and non-teratogenic prescribed drugs during pregnancy, and congenital disabilities with known effects on cognition and learning—are associated with a range of neurodevelopmental disabilities. These disabilities are often detectable in infancy or early childhood, permitting early intervention to mitigate their effects, and are formally defined by the neurodevelopmental assessments of World Health Organization collaborators. They include prenatal alcohol spectrum disorders; neurodevelopmental consequences of maternal illicit substance use; and neurodevelopmental problems associated with congenital central nervous system malformations. The association between prenatal substance exposure and learning outcomes can also be judged at the population level. Infants and young children exposed to these substances in utero tend to deviate from the common motor, language, and cognitive development trajectories, which can affect performance in the classroom. A growing number of studies have linked prenatal substance exposure to impaired literacy and numeracy outcomes, and others indicate that a large proportion of children exposed in utero to drugs or alcohol do not adapt well to instruction in school.

6.2. Evidence-Based Teaching Approaches and Accommodations

Pedagogical methods, classroom modifications, and assistive technologies proven to support this population must now be aligned with assessment findings. Evidence-based teaching approaches may belong to the Behavioural or Direct Instruction families. Though presented separately for clarity, they need not be mutually exclusive, as many teachers naturally take aspects from both orientations to provide responsive instruction. The general principles of Behavioural approaches are to present information in small steps, follow each step with accuracy checks, provide immediate feedback, and systematically adapt further stages of instruction on the strength of the student's responses, maintaining a pollution-free zone for each skill as much as possible. Such procedures and more complex variants, known as Traditional Teaching Methods, are the best match for acquisition learning. Many of the more complex variants also provide good support for comprehension learning, where these methods are known as Task Analysis. Response-controlled task variations, called Direct Instruction, optimise acquisition learning.

Good progress on literacy requires a strong emphasis on phonological awareness and phonemic decoding in the preparatory years, a strong whole-language or similar approach for initial reading, careful attention to vocabulary acquisition and grammatical development during early primary school for students learning English as a second language, and an emphasis on higher level inferential comprehension skills during the later primary years. For numeracy, at least initial instruction in number and addition fact retrieval should be in a whole-part-whole mode using a depth-first, depth-first, breadth-last instructional sequence, and younger students should not be overloaded on number lines or higher roles of the number facts. (Prasad, R., & Anjali, K. 2018)

7. Research Gaps

Learning difficulties are a major public health concern. Failure to adequately modify educational trajectories to meet these learning needs may emerge in reduced reading and math accomplishments and lesser instructional adaptation. Therefore, understanding how prenatal substance exposure influences learning-relevant neurodevelopmental pathways—from motor and cognitive development to academic progress—forms a central part of the knowledge base for planning the setting of educational goals and defining effective pedagogical responses. Nevertheless, studies linking prenatal substance exposure explicitly to learning outcomes remain rare. Inclusion requirements such as longitudinally assessed learning difficulties at key developmental milestones and in well-characterized original cohorts may restrict the options for identifying, mapping, and appraising longitudinal trajectories that align with educational policy and practice. Explicating and communicating findings along the lines of recognized educational goals, methods, milestones, and periods helps underline their relevance for systemic decision-making.

Fetal exposure to psychoactive substances may impact neurodevelopment and produce distinctive disabilities with implications for learning. Rigorous examination of causal pathways and learning-associated trajectories is complicated by complex interactions among substance type, timing, and dosage; maternal lifestyle factors; co-occurring congenital disabilities; and intersecting legislative, health, educational, and social variables. Evidence on these interactions is critical for elucidating how prenatal exposure influences educational needs, enabling better identification and monitoring of at-risk children. A broad definition of psychoactive substances encompasses any pharmacologically active compounds, whether licit or illicit, that may affect learning or behaviour. Teratogenic substances directly disturb fetal development, producing congenital disabilities. Other substances exert no direct teratogenic effect but may influence the developmental trajectory of pre-existing conditions. Fetal Alcohol Spectrum Disorders exemplify both situations: ethanol is teratogenic, damaging diverse developing systems, whereas amphetamines and nicotine lack teratogenic action but may modify the neural substrates and severity of other congenital conditions, thus indirectly influencing early learning. (Prasad, R., & Anjali, K. 2018).

Students at greatest risk of having learning difficulties or learning disabilities can be identified with careful screening and multidisciplinary evaluation. Conversely, prospective longitudinal studies of children at risk permit strong conclusions about likely deficits in later life and provide a basis for preventive interventions or appropriately structured intervention. Control groups of children not at risk allow investigation of how specific disabilities impact academic outcomes, including achievement in literacy and numeracy, appropriate modifications of the curriculum, and response to special support. Studies exploring the association between prenatal exposure to a known agent and school performance have unparalleled power for informing education policy and practice. The agent could be a drug known to have had an impact on neurodevelopment, including the central nervous system teratogen alcohol or combinations of substances such as cocaine and alcohol associated with subsequent learning impairment, and school performance

could include academic attainment. The lessons are clear: for such studies neither exposure to a single agent nor academic achievement alone allows an understanding of the determinants of any neurodevelopmental risk; for this risk to be minimized, support for students must be provided across the domain of learning, not just remediation in a single subject area. (Jain, A., & Sharma, P. 2023)

8. Conclusion

The preceding sections have presented an analysis of how prenatal exposure to substances and accompanying fetal disabilities may shape children's later learning trajectories. Attention to these connections is increasingly urgent as the opioid epidemic and other substance-use dynamics heighten the risk of such exposure in the population. As the analysis has revealed, specific cohorts of affected children can be identified based on different mixes of substances and distinct fetal disabilities, each of which is associated with differential impacts on behavior, cognition, and academic achievement. Therefore, individuals responsible for policy, research, or practice should concentrate their efforts on such cohorts, given the widespread implications of substance exposure for the population at large and the mounting demand for targeted initiatives in the field of early-life learning. To stimulate research that clarifies the links between prenatal substance exposure and children's learning trajectories, it would be worthwhile to establish formalized networks to share information and recommendations. These networks could facilitate dialogue around data sources, indicators and measures, cohorts, instruments, and transmission mechanisms, guiding systematic studies that explore the relations between exposure and learning outcomes. Furthermore, bringing together stakeholders engaged with these issues would foster broader coordination and mobilization of relevant actors. Establishing and reinforcing channels through which general educational policy might be influenced in accordance with this content also merits attention.

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