



Submitted on: 06/19/2024

Approved on: 01/23/2025

REVIEW ARTICLE

## Impact of drug abuse during pregnancy on the neuropsychomotor development

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### Keywords:

Pregnancy,  
Alcoholism,  
Infant,  
newborn,  
Nicotine,  
Cocaine,  
Marijuana use.

### Abstract

The neuropsychomotor development involves the formation of language, cognition, motor skills, and social abilities. This process can be influenced by various factors, such as the use of drugs during pregnancy. This study aims to ascertain the alterations in the neuropsychomotor development of newborns born to women who used legal drugs such as tobacco and alcohol, and/or illegal drugs such as marijuana, cocaine, and crack during pregnancy. This literature review was conducted by searching for articles published in Portuguese, English, Spanish, and French in the PubMed and Scientific Electronic Library Online (SciELO) databases, published and indexed in the last 10 years. Based on the selected articles, they were categorized for analysis according to drug exposure to the fetus during gestation: (1) alcohol; (2) tobacco; (3) cocaine and crack; (4) marijuana. Complex alterations were found in the neuropsychomotor development of newborns, with long-term consequences, thus necessitating better screening, monitoring, and support for pregnant women, prioritizing complete abstinence from these substances and avoiding such outcomes.

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## INTRODUCTION

Neuropsychomotor development involves the formation of language, cognition, motor skills, and social skills and is the result of biological, environmental, physical, social, and emotional factors. This process occurs meticulously and can be affected by a variety of factors<sup>1</sup>. During fetal development, several stages of brain development occur, such as neuronal migration, synaptogenesis, and the expression of receptors that can be targets of substances consumed by the mother<sup>2</sup>. Drug use during pregnancy can lead to permanent anatomical and functional consequences in the fetal brain, as most drugs of abuse easily cross the placenta and can affect the development of the newborn's nervous system<sup>2-6</sup>. The main substances used are the most commonly used legal drugs, such as alcohol and tobacco, and illicit drugs, such as marijuana, cocaine, and crack, which affect both mother and fetus. Therefore, it is necessary to create and use techniques that allow the tracking and monitoring of gestational exposure to drugs of abuse, aiming at prevention and early intervention in order to avoid and reduce neonatal and postnatal damage<sup>2,4,7,8</sup>.

## MATERIALS AND METHODS

This is an integrative review, with data collected from secondary sources through a bibliographic survey. To identify articles in the literature, a search will be conducted using the following descriptors: "pregnancy," "drugs during pregnancy," "newborn," "nicotine," "alcoholism," and "illicit drugs" in the following databases: PubMed and Scientific Electronic Library Online (SciELO). The inclusion criteria for article selection will be: articles published in Portuguese, English, Spanish, and French; full-text articles that address the topic of the integrative review; and articles published and indexed in the aforementioned databases within the last 10 years.

## OBJECTIVE

The main objective of this study is to identify changes in the neuropsychomotor development of newborns born to mothers who used legal drugs, such as tobacco and alcohol, and/or illegal drugs, such as marijuana, cocaine and crack, during pregnancy.

## RESULTS

### Alcohol

Alcohol is a teratogenic substance and can cause problems for newborns, as it is absorbed through the placenta and transported to the fetal bloodstream. Alcohol use during pregnancy predisposes fetuses to health risks and is linked to outcomes such as fetal growth restriction, fetal alcohol syndrome (FAS), a serious condition associated with reduced

brain weight and cognitive delays, and fetal alcohol spectrum disorders (FASD), which result in congenital malformations<sup>2,9</sup>.

The degree of impairment in the child depends on the gestational age and the type of alcohol consumed. Structural malformations, including severe ones, are most common up to the 8th week of gestation, known as the embryonic period. Between the 9th and 40th weeks of gestation, the central nervous system (CNS) may present dysfunctions, in addition to the risk of miscarriage<sup>8</sup>. Other health consequences for the fetus and newborn resulting from alcohol consumption during pregnancy include decreased brain weight, reduced birth weight, cognitive delays, premature birth, and stillbirth, as well as cranial malformations<sup>2,9</sup>. Hearing and vision changes may also be observed. Newborns with FASD may have a reduced head circumference and may develop neuropsychomotor changes, such as coordination and behavioral problems and reduced attention span<sup>9</sup>.

Thus, to protect mothers and newborns from the harmful effects of alcohol during pregnancy, it is important to support and guide pregnant women who consume alcohol during prenatal care<sup>10</sup>. Therefore, interventions such as motivational interviews, which can reduce alcohol consumption during pregnancy, public awareness and education through the media, and community health workers' work in screening and social support to prevent alcohol use during this phase of a woman's life are necessary<sup>11</sup>. And, most importantly, complete abstinence from alcohol during pregnancy<sup>8</sup>.

### Tobacco

Contrary to popular belief, legal drugs, such as tobacco, can cause as much harm to the fetus during its development as illegal substances, and may even be more harmful<sup>7,11</sup>. Smoking during pregnancy not only has detrimental effects on the birth, such as premature placental abruption and low birth weight, but can also lead to changes in neurodevelopment<sup>2,11-13</sup>. For a newborn's brain to function properly, the central nervous system must mature and be properly organized. However, during pregnancy, the developing nervous system becomes more plastic and, therefore, more susceptible to the harmful effects of tobacco components<sup>13</sup>.

The main psychoactive substance in tobacco is nicotine, and even with knowledge of its harmful health consequences, its use remains a pending issue for global health<sup>2,12</sup>. Nicotine is an agonist of the nicotinic acetylcholine receptor (nAChR) and crosses the placental barrier, along with its metabolite, cotinine. This receptor is expressed in humans from early fetal formation, found in numerous regions of the brain, and through it, several changes occur in the development of the nervous system when the fetus is exposed to nicotine<sup>2,12,13</sup>. One of the causes of these CNS imbalances may be related to dysfunctions in cell proliferation and differentiation in the fetus, with impaired cholinergic system, a fundamental player in brain formation<sup>2,5</sup>.

In addition to affecting the cholinergic system, this substance also affects the dopaminergic, noradrenergic, and GABAergic systems, interfering with synapse formation, neurotransmitter release, and neuronal migration<sup>2,12</sup>. A study with mice<sup>12</sup> analyzed the exposure of the developing central nervous system to nicotine and observed changes in neural networks involving the frontal cortex, a region important for memory, attention, cognition, and emotional regulation, the cerebellum and striatum, and the catecholamine and GABA signaling pathways in the frontal cortex<sup>12,13</sup>. Thus, it is known that tobacco components can cause various anatomical and functional damage to the nervous system during fetal development, which can lead to short- and long-term neuropsychomotor disorders<sup>2,12,13</sup>.

Intrauterine exposure to nicotine leads to increased irritability, muscle tone, tremors, and sudden musculoskeletal responses, reduced attention, and altered speech projection in newborns. A greater reactivity to auditory stimuli can also be observed, favoring the emergence of long-term learning and language deficits<sup>2</sup>. In addition to low birth weight, newborns may have smaller height and head circumference and are more likely to be admitted to neonatal intensive care units (NICUs), a factor that can also increase the risk of neuropsychomotor developmental delays, depending on the length of hospitalization<sup>2,7</sup>. Secondhand smoke is also a causative agent of cognitive and behavioral problems in exposed newborns<sup>11</sup>.

The effects of smoking during pregnancy are not limited to newborns, but can persist throughout their lives. Learning, attention, and memory difficulties, psychiatric disorders such as anxiety and behavioral problems, and poor motor performance can be found in children and adolescents who were exposed to tobacco during pregnancy<sup>2,5,7,12</sup>.

It is important to emphasize that the use of electronic cigarettes and passive smoking by pregnant women are also harmful to fetal neurodevelopment, due to the high toxicity of nicotine<sup>2,13</sup>.

Therefore, given all the harm suffered by newborns and caused by exposure to smoking in the prenatal period, it is necessary to stop smoking before pregnancy, in order to avoid neuropsychomotor development disorders in the newborn and their future consequences<sup>2,7,11</sup>.

## Cocaine and Crack

Cocaine can also cross the placental and blood-brain barriers, and its use negatively affects pregnancy, potentially leading to premature birth or even affecting fetal growth, with decreased length and birth weight due to the drug's vasoconstrictive effect, which reduces blood flow to the fetus<sup>2,14</sup>. Crack use during pregnancy can cause early rupture of the amniotic sac and placental abruption, in addition to compromising the child's neuropsychomotor development<sup>10</sup>.

Inadequate brain development in newborns of cocaine-using mothers can be observed by a decreased head circumference, a predictor of neurobehavioral changes and microcephaly<sup>9</sup>. Language, performance, and behavioral deficits can be observed in patients exposed to cocaine during pregnancy. Motor impairments, decreased arousal, nervousness, and altered reflexes have been observed in infants<sup>2</sup>. Behavioral disorders can also be present in newborns of crack users<sup>6</sup>.

However, it is worth noting that the changes seen in newborns depend on the time of exposure to the drug, its quantity and the gestational period<sup>2,7,9</sup>. Thus, a study carried out in 2013, by Richardson et al., reported that when a fetus is exposed to cocaine in the first trimester, it may have behavioral and anxiety problems and reduced sociability in the future<sup>2,15</sup>.

Regarding anatomical and functional disorders, cortical infarctions, neuronal migration disorders and a higher frequency of periventricular hemorrhages were observed in individuals exposed to cocaine during pregnancy in magnetic resonance studies reported by Chris Derauf et al.<sup>16,17</sup>.

Therefore, given the risks and complications in newborns exposed to cocaine and crack during the intrauterine period, it is necessary to create and apply clinical protocols for the management of these patients<sup>6</sup>.

## Marihuana

Marijuana is the most commonly used illicit drug during pregnancy and lactation, and may be seen by many as the most harmless. However, this substance causes several harmful effects, including in utero<sup>11</sup>. Furthermore, given increased anxiety, such as during the COVID-19 pandemic, marijuana use has become more frequent among people of childbearing age<sup>4</sup>. Marijuana use during pregnancy has been associated with premature birth, decreased birth weight, and even stillbirth<sup>9,18</sup>.

This drug is formed by the active substance delta-9-tetrahydrocannabinol (THC), which has the ability to bind to the cannabinoid-1 (CB-1) receptor, present in the second trimester of pregnancy, affecting fetal development and potentially leading to structural brain changes, some of which occur in the nucleus accumbens, when there is intrauterine exposure to marijuana<sup>2,9</sup>. Furthermore, it is known that exposure to marijuana in the prenatal phase affects learning and memory<sup>2</sup>.

Regarding the postpartum period, the effects observed in newborns exposed to marijuana are disorders sleep, alteration to stimuli visual impairment, alertness, excitability, and tremors<sup>2,16</sup>. Regarding breastfeeding, the chemical components of marijuana, especially THC, can be passed through breast milk, requiring greater diligence from health professionals, as the exposed child may also have impaired motor development<sup>18</sup>.

The harmful effects of marijuana during pregnancy don't just affect the newborn. Studies show neurobehavioral deficits, such as in executive functions, and neuropsychiatric changes in older children as well. Furthermore, an increase in THC concentrations in marijuana has been observed, raising the awareness of healthcare professionals on the issue.

## CONCLUSION

It is concluded that newborns born to mothers who used licit and/or illicit drugs during the gestational period may have changes in neuropsychomotor development, with the brain being the main structure affected<sup>2</sup>.

Among the most commonly used legal drugs are alcohol, which affects differently depending on the period of pregnancy, and tobacco, which harms different systems of the body, mainly in the anatomical and functional aspects of the nervous system during fetal development<sup>2,8,12,13</sup>.

Among illicit drugs, marijuana stands out, although its consequences are often underestimated, but it causes several damages throughout the life of the exposed fetus<sup>11</sup>. Furthermore, crack cocaine is associated with premature births, and cocaine is related to impaired fetal physical growth and other neurological and behavioral problems depending on the length of exposure<sup>2,18</sup>.

Therefore, there is a need to improve strategies for screening and monitoring in utero drug exposure, through screening by community workers and prenatal consultations, in order to prevent problems related to the neuropsychomotor development of newborns and children<sup>7,10,11</sup>. Furthermore, public education, raising awareness through the media, and encouraging social support are also resources that contribute to preventing the consumption of harmful substances during pregnancy<sup>11</sup>.

## REFERENCES

1. Dornelas L de F, Duarte NM de C, Magalhães L de C. Atraso do desenvolvimento neuropsicomotor: mapa conceitual, definições, usos e limitações do termo. *Rev Paul Pediatr* [Internet]. 2015 Mar; [citado 2023 Jul 8]; 33(1):88-103. Disponível em: [http://www.scielo.br/pdf/rpp/v33n1/pt\\_0103-0582-rpp-33-01-00088.pdf](http://www.scielo.br/pdf/rpp/v33n1/pt_0103-0582-rpp-33-01-00088.pdf).
2. Ross EJ, Graham DL, Money KM, Stanwood GD. Developmental Consequences of Fetal Exposure to Drugs: What We Know and What We Still Must Learn. *Neuropsychopharmacology* [Internet]. 2015 Jun 18; [cited 2023 Jul 8]; 40(1):61-87. DOI: <https://doi.org/10.1038/npp.2014.147>. Available from: <https://www.nature.com/articles/npp2014147>.
3. Rocha PC, Britto e Alves MTSS de, Chagas DC das, Silva AAM da, Batista RFL, Silva RA da. Prevalência e fatores associados ao uso de drogas ilícitas em gestantes da coorte BRISA. *Cad Saúde Pública* [Internet]. 2016; [citado 2023 Jul 8]; 32(1). DOI: <https://doi.org/10.1590/0102-311X00192714>. Available from: <https://www.scielo.br/j/csp/a/ws3gjWCYsWnZPcGsZ5qr4qK/?lang=pt>.
4. Lo JO, Hedges JC, Girardi G. Impact of cannabinoids on pregnancy, reproductive health, and offspring outcomes. *Am J Obstet Gynecol* [Internet]. 2022 Oct 1; [cited 2023 Jul 8]; 227(4):571-81. DOI: <https://doi.org/10.1016/j.ajog.2022.05.056>. Available from: <https://pubmed.ncbi.nlm.nih.gov/35662548/>.
5. Lamy S, Laqueille X, Thibaut F. Conséquences potentielles de la consommation de tabac, de cannabis et de cocaïne par la femme enceinte sur la grossesse, le nouveau-né et l'enfant: revue de littérature. *Encephale* [Internet]. 2015 Jun; [cited 2023 Jul 8]; 41:S13-20. DOI: <https://doi.org/10.1016/j.encep.2014.08.012>. Available from: <https://www.sciencedirect.com/science/article/abs/pii/S0013700614002024?via%3Dihub>.
6. Reis FT, Loureiro RJ. Repercussões neonatais decorrentes da exposição ao crack durante a gestação. *SMAD Rev Eletrônica Saúde Mental Álcool Drog* [Internet]. 2015 Dec 1; [citado 2023 Jul 8]; 11(4):217. DOI: <https://doi.org/10.11606/issn.1806-6976.v11i4p217-224>. Disponível em: <https://revistas.usp.br/smad/article/view/116780>.
7. Lima RE de, Aleixo AA, Araújo LB, Nascimento CP, Azevedo VMG de O. Neuropsychomotor development characteristics of the infants who born from women who abused drugs during pregnancy. *J Hum Growth Dev* [Internet]. 2018 Mar 12; [cited 2023 Jul 8]; 28(1):27. DOI: <https://doi.org/10.7322/jhgd.134374>. Available from: <https://revistas.usp.br/jhgd/article/view/134374>.
8. Mariani Neto C, Segre CA de M, Grinfeld H, Costa H de PF. Efeitos do álcool no feto e no recém-nascido. *Femina* [Internet]. 2019; [citado 2023 Jul 8]; 47(3):167-9. Disponível em: <https://pesquisa.bvsalud.org/bvsms/resource/pt/biblio-1046505>.
9. Etemadi-Aleagha A, Akhgari M. Psychotropic drug abuse in pregnancy and its impact on child neurodevelopment: A review. *World J Clin Pediatr* [Internet]. 2022 Jan 9; [cited 2023 Jul 8]; 11(1):1-13. DOI: <https://doi.org/10.5409/wjcp.v11.i1.1>. Available from: <https://www.wjnet.com/2219-2808/full/v11/i1/1.htm>.
10. Dutra AGR, Oliveira AG de, Carneiro BAP, Medeiros EC, Veiga KGC, Lima RSG, et al. Complicações gestacionais relacionadas ao uso de drogas por gestantes. *REAC* [Internet]. 2021 ago 31; [citado 2023 Jul 8]; 35:e8702. Disponível em: <https://acervomais.com.br/index.php/cientifico/article/view/8702>.
11. Forray A, Foster D. Substance Use in the Perinatal Period. *Curr Psychiatry Rep* [Internet]. 2015 Sep 19; [cited 2023 Jul 8]; 17(11). DOI: <https://doi.org/10.1007/s11920-015-0626-5>. Available from: <https://link.springer.com/article/10.1007/s11920-015-0626-5>.
12. McCarthy DM, Zhang L, Wilkes BJ, Vaillancourt DE, Biederman J, Bhide PG. Nicotine and the developing brain: Insights from preclinical models. *Pharmacol Biochem Behav*. 2022 Mar;214:173355. DOI: <https://doi.org/10.1016/j.pbb.2022.173355>.
13. Castro EM, Lotfipour S, Leslie FM. Nicotine on the developing brain. *Pharmacol Res* [Internet]. 2023 Apr 1; [cited 2023 Jul 8]; 190:106716. Available from: <https://www.sciencedirect.com/science/article/pii/S1043661823000725?via%3Dihub>.
14. Silva FM da, Algeri S, Cunha AAD da, Oliveira CP de. Crack na gestação: consequências no crescimento/desenvolvimento do feto e recém-nascido. *Rev enferm UFPE on line* [Internet]. 2016; [cited 2023 Jul 8]; 10(Suppl 6):4934-41. Disponível em: <https://pesquisa.bvsalud.org/bvsms/resource/pt/biblio-1031747>.
15. Richardson GA, Goldschmidt L, Larkby C, Day NL. Effects of prenatal cocaine exposure on child behavior and growth at 10 years of age. *Neurotoxicol Teratol*. 2013 Nov-Dec;40:1-8. doi:10.1016/j.ntt.2013.08.001.
16. Paula RDSK de. Consequências à criança do uso de drogas durante a gestação: um artigo de revisão. *Rev Med UFC* [Internet]. 2018 Mar 28 [citado em 2023 jul 8];58(1):45. doi: <http://doi.org/10.20513/2447-6595.2018v58n1p45-52>.

17. Derauf C, Kekatpure M, Neyzi N, Lester B, Kosofsky B. Neuroimaging of children following prenatal drug exposure. *Semin Cell Dev Biol.* 2009 Jun;20(4):441–454. doi:10.1016/j.semdb.2009.03.001.
18. Ministério da Cidadania (BR), Secretaria Nacional de Cuidados e Prevenção às Drogas, Secretaria Nacional de Atenção à Primeira

Infância. Conhecendo os efeitos do uso de drogas na gestação e as consequências para os bebês. Brasília: Ministério da Cidadania, 2021[citado em 2023 jul 10]. Disponível em: [https://www.gov.br/mds/pt-br/pt-br/noticias-e-conteudos/desenvolvimento-social/noticias-desenvolvimento-social/ministerio-da-cidadania-lanca-cartilha-sobre-efeitos-e-consequencias-do-uso-de-drogas-na-gestacao/30042021\\_cartilha\\_gestantes.pdf](https://www.gov.br/mds/pt-br/pt-br/noticias-e-conteudos/desenvolvimento-social/noticias-desenvolvimento-social/ministerio-da-cidadania-lanca-cartilha-sobre-efeitos-e-consequencias-do-uso-de-drogas-na-gestacao/30042021_cartilha_gestantes.pdf)