

Clearing the Smoke on Cannabis

Maternal Cannabis Use During Pregnancy

Amy J. Porath-Waller, Ph.D.

Senior Research & Policy Analyst, CCSA



Canadian Centre on
Substance Abuse

This is the second in a series of reports that reviews the effects of cannabis use on various aspects of human functioning and development. In this report, the effects of maternal cannabis use during pregnancy on offspring are presented. Other reports in this series address the effects of chronic cannabis use on cognitive functioning and mental health, cannabis use and driving, and respiratory effects of cannabis use.

Background

Cannabis is the most widely used illicit drug in Canada. According to the 2004 Canadian Addiction Survey (CAS), nearly 45% of Canadians aged 15 years and older reported using cannabis at least once and 14% reported use in the past year (Adlaf, Begin, & Sawka, 2005). The use of cannabis is generally more prevalent among youth, with 39.3% of 15- to 17-year-olds and 69.9% of 18- to 19-year-olds reporting lifetime use. Rates of past-year use increase from 15–17 years of age (29.2%) to 18–19 years of age (47.2%). Approximately 46% of past-year cannabis users in Canada aged 15 and older reported using cannabis two or fewer times during the three months prior to the survey. A sizable percentage of past-year users indicated that they use cannabis more regularly on either a weekly (20.1%) or daily (18.1%) basis.

A growing body of evidence suggests that cannabis use may negatively impact several aspects of people's lives, including mental and physical health, cognitive functioning, ability to drive a motor vehicle, and pre- and postnatal development among offspring. In this report—the second in a series reviewing the effects of cannabis use on various aspects of human functioning and development (see Porath-Waller, 2009)—the effects of prenatal cannabis exposure on offspring birth outcomes,



neurocognitive development, behaviour and mental health are explored. Following a review of the evidence, this report discusses implications for policy and practice.

Much of the available evidence on this topic originates from two prospective longitudinal cohort studies that mainly describe the impact of heavy cannabis use on offspring outcomes. The Ottawa Prenatal Prospective Study (OPPS) was initiated in 1978 and consists of White, predominantly middle-class families, while the Maternal Health Practices and Child Development Project in Pittsburgh (MHPCDP) commenced in 1982 and is based on a cohort of mostly African-American individuals from low socioeconomic backgrounds. These studies began when the female subjects were pregnant and have followed their offspring into adolescence and early adulthood. Unlike a retrospective study design, the prospective longitudinal nature of the OPPS and MHPCDP allows for accurate and reliable measurement of the extent and timing of cannabis exposure during pregnancy and numerous lifestyle variables (e.g., maternal health, socioeconomic status, maternal use of drugs other than cannabis, etc.) that may impact offspring's behaviour and functioning.

Cannabis is a tobacco-like greenish or brownish material consisting of the dried flowering, fruiting tops and leaves of the cannabis plant, *Cannabis sativa*. Hashish or cannabis resin is the dried brown or black resinous secretion of the flowering tops of the cannabis plant. Cannabis produces euphoria and relaxation, changes in perception, time distortion, deficits in attention span and memory, body tremors, and impaired motor functioning. It is a controlled substance under the *Controlled Drugs and Substances Act*—meaning that the acts of growing, possessing, distributing and/or selling cannabis are illegal.

Prevalence of Cannabis Use During Pregnancy

Cannabis is the most frequently used illicit drug that is ingested during pregnancy, with 2.8% of pregnant women reporting past-month use in the 2005 National Survey on Drug Use and Health in

the United States (Substance Abuse and Mental Health Services Administration [SAMHSA], 2006). Canadian data on the prevalence of maternal cannabis use during pregnancy are scarce. A report from the Reproductive Health Working Group (2006) in Alberta indicated that 2.3% of women who gave birth to live infants in 2006 reported using street drugs while pregnant, with cannabis being the most commonly used substance. These figures, however, are considerably below those reported by a number of prospective, longitudinal cohort studies investigating cannabis use during pregnancy, which state rates of use ranging

from 10–16% in middle-class samples to 23–30% in inner-city populations (Fried, 2002).

Effects on Birth Outcomes

No evidence exists that suggests an association of cannabis use during pregnancy with an increased risk of premature birth, miscarriage, or major physical abnormalities (Day et al., 1991; Fried, Buckingham, & Von Kulmiz, 1983), after controlling for maternal tobacco, alcohol and other illicit drug use and various

demographic covariates. However, some reports indicate hypertelorism (increased distance between the eyes) and severe epicanthus (skin fold of the upper eye lid) (O’Connell & Fried, 1984), a five-fold increase in features consistent with fetal alcohol

reported smoking one or more marijuana cigarettes per day, after controlling for significant covariates (Goldschmidt, Richardson, Willford, & Day, 2008). In children around the age of nine, prenatal cannabis exposure has been linked with impaired abstract and



Beginning at age three to four, children of mothers who used cannabis heavily while pregnant have demonstrated deficits in memory, verbal and perceptual skills, and verbal and visual reasoning after adjusting for potentially confounding variables

Impaired performance in verbal and quantitative reasoning and short-term memory has also been found among six-year-old children whose mothers reported smoking one or more marijuana cigarettes per day, after controlling for significant covariates

In children around the age of nine, prenatal cannabis exposure has been linked with impaired abstract and visual reasoning, poor performance on tasks reflecting executive functioning, and deficits in reading, spelling, and achievement, independent of various covariates

Porath and Fried (2005) reported that 16- to 21-year-old offspring (particularly males) of cannabis users were at increased risk, in a dose-related manner, for the initiation of cigarette smoking and cannabis use, and daily cigarette smoking, compared to offspring of non-using mothers, independent of potential prenatal confounds

Findings from brain imaging studies of young adults aged 18–22 indicate that *in utero* cannabis exposure negatively impacts the neural circuitry involved in aspects of executive functioning, including response inhibition and visuospatial working memory

syndrome (Hingson et al., 1982), and reduced birth weight and body length (Fergusson, Horwood, & Northstone, 2002) in children of heavy cannabis-using mothers.

Effects on Neurocognitive Functioning

Maternal cannabis use during pregnancy has subtle effects on offspring’s neurocognitive functioning. Beginning at age three to four, children of mothers who used cannabis heavily while pregnant have demonstrated deficits in memory, verbal and perceptual skills, and verbal and visual reasoning after adjusting for potentially confounding variables (Day et al., 1994; Fried & Watkinson, 1990). Impaired performance in verbal and quantitative reasoning and short-term memory has also been found among six-year-old children whose mothers

visual reasoning, poor performance on tasks reflecting executive functioning (i.e., visual-motor integration, nonverbal concept formation, and problem solving), and deficits in reading, spelling, and achievement, independent of various covariates (Fried, Watkinson & Gray, 1998; Fried & Watkinson, 2000; Goldschmidt, Richardson, Cornelius, & Day, 2004; Richardson, Ryan, Willford, Day & Goldschmidt, 2002). Vulnerability in visual-cognitive functioning has been shown to persist into early adolescence among those offspring heavily exposed to cannabis (Fried, Watkinson, & Gray, 2003). Findings from brain imaging studies of young adults aged 18–22 indicate that *in utero* cannabis exposure negatively impacts the neural circuitry involved in aspects of executive functioning, including response inhibition and visuospatial working memory (Smith, Fried, Hogan, & Cameron, 2004, 2006). These findings



are particularly noteworthy as they demonstrate the long-term impairing effects of prenatal exposure to cannabis on offspring's neurocognitive functioning. Global intelligence does not appear to be impacted by prenatal cannabis exposure (Fried et al., 1998, 2003).

Behavioural Effects

The behavioural effects of prenatal cannabis exposure have also been documented, although it is unclear as to how early such effects first present themselves. Whereas some studies have failed to find evidence of a negative relationship between cannabis exposure and attention among four-year-old children (Fried & Watkinson, 1990), others have reported impaired vigilance among exposed children at this age, independent of potential confounding variables (Noland et al., 2005). When children reach age six, the effects of maternal cannabis use during pregnancy become much more evident. Compared to offspring of non-users, children born to cannabis users—particularly heavy users—have been found to be more hyperactive, inattentive, and impulsive (Fried, Watkinson, & Gray, 1992; Leech, Richardson, Goldschmidt, & Day, 1999), even after controlling for extraneous variables. At age 10, prenatally exposed children display increased hyperactivity, inattention, and impulsivity, and show increased rates of delinquency and externalizing problems as reported by their mothers and teachers, compared to those children who were not exposed prenatally to cannabis (Fried et al., 1998; Goldschmidt, Day, & Richardson, 2000). In children aged 13–16, however, some aspects of attention (i.e., flexibility, encoding and focusing) appear to no longer be affected by cannabis exposure (Fried et al., 2003).

There is accumulating evidence that suggests prenatal cannabis exposure may contribute to the initiation

and frequency of subsequent substance use during adolescence. Porath and Fried (2005) reported that 16- to 21-year-old offspring (particularly males) of cannabis users were at increased risk, in a dose-related manner, for the initiation of cigarette smoking and cannabis use, and daily cigarette smoking, compared to offspring of non-using mothers, independent of potential prenatal confounds. Similar results were noted by Day, Goldschmidt, and Thomas (2006); compared to offspring of non-users, youth of mothers who heavily used cannabis while pregnant not only reported using this substance more frequently at age 14, but they also initiated use at an earlier age. This result was significant even after controlling for potential confounds.

Effects on Mental Health

There is emerging evidence linking *in utero* cannabis exposure to depressive and anxious symptomatology. After controlling for prenatal exposure to other drugs and risk factors for childhood depression, offspring of maternal cannabis users expressed significantly more depressive and anxious symptoms at age 10 compared to children of non-users (Gray, Day, Leech, & Richardson, 2005; Leech, Larkby, Day, & Day, 2006).

Mechanisms of Action

The mechanisms responsible for the effects of prenatal cannabis exposure are not well understood. Cannabinoids are able to cross the placental barrier and may affect the expression of key genes for neural development, leading to neurotransmitter and behavioural disturbances (Gomez et al., 2003). The presence of cannabinoid receptors in the placenta and fetal brain may also mediate adverse actions of prenatal cannabis exposure (Park, Gibbons, Mitchell,

& Glass, 2003), as these receptors are associated with aspects of brain functioning including cognition and memory (Kumar, Chambers, Pertwee, 2001). Animal studies have documented that cannabinoids can lead to changes in dopamine activity and impaired functioning of the hypothalamus-pituitary-adrenal axis (Kumar et al., 2001), which may affect mood and neurobehavioural outcomes in offspring. It is also possible that an underlying genetic factor may account for both the lifestyle habits of the pregnant mother (i.e., cannabis use) and her child's neurodevelopment and behaviour.

Conclusions and Implications

Evidence does suggest that prenatal exposure to cannabis (particularly heavy exposure) has subtle adverse effects, beginning at approximately three years of age, on subsequent cognitive functioning, behaviour, substance use, and mental health in offspring. Cannabis-related deficits in the cognitive domain could impair a child's academic functioning and may require educational remediation,

enrichment or placement to help protect against future learning problems. Prevention efforts directed towards reducing maternal cannabis use during pregnancy could have significant effects in reducing such cognitive impairment. Prevention and intervention programs aimed at reducing prenatal cannabis exposure could also help reduce the percentage of youth who experience mental health conditions and other comorbid problem behaviours, such as substance use and delinquency.

It has been reported that at least half of all pregnancies in North America are unplanned (Walker, Rosenberg, & Balaban, 1999). That, combined with the fact that nearly 7% of American women of childbearing age (15–44 years) reported past-month use of marijuana and hashish in 2005 (SAMHSA, 2006) indicates the potential risk for offspring to be prenatally exposed to cannabis. Cannabis use is a preventable prenatal risk factor; the findings reviewed from the literature suggest that it is prudent to advise pregnant women, and women thinking of becoming pregnant, of the risks associated with cannabis use during pregnancy.

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Canadian Centre on Substance Abuse

75 Albert Street, Suite 500
Ottawa, ON K1P 5E7
Canada
Phone: (613) 235-4048
Fax: (613) 235-8101
info@ccsa.ca
Website: www.ccsa.ca

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