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Attitudes and Beliefs of Cannabis Use During Pregnancy: Hashing out the Impact of Location and Legality

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A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science at Virginia Commonwealth University.

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Abstract

ATTITUDES AND BELIEFS OF CANNABIS USE DURING PREGNANCY: HASHING OUT THE IMPACT OF LOCATION AND LEGALITY

By Anna Wiese, B.S., B.A.

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As more states authorize the use of cannabis for medical and recreational purposes, rates of prenatal cannabis use are on the rise. Yet research on perceptions of prenatal cannabis use has been limited, and the existing research lacks reliable, quantitative measures. In response, researchers in Denver developed the Perceptions of Prenatal Cannabis Use (PPCU) survey, a 16-item measure designed to assess perceived risks and benefits of prenatal cannabis use. The present study analyzed PPCU survey data administered at three different recruitment sites (Denver, CO; Pittsburgh, PA; and Richmond, VA). The present study examined women's perceptions of the risks and benefits of cannabis use (both generally and during pregnancy), assessed the psychometric properties of the PPCU survey, and compared perceptions of prenatal cannabis use across demographic variables and recruitment sites. It was hypothesized that women who were younger, unmarried, less educated, and recent cannabis users would view

prenatal cannabis use as more safe/beneficial. Examining data across all three recruitment sites (N = 582), while participants endorsed a mixture of both risks and benefits of cannabis use by the general public, they expressed more uncertainty when rating the risks and benefits of cannabis use during pregnancy. Additionally, the current study found the PPCU to be a reliable measure. Further, in line with hypotheses, women across the total sample were more likely to view prenatal cannabis use as safe/beneficial if they were younger, unmarried, and less educated, as well as if they were recent cannabis users. Finally, when looking across the three sites, women in Denver were more likely to perceive prenatal cannabis use as safe/beneficial than women in Pittsburgh or Richmond. These findings emphasize the need for further research and education on the potential risks and benefits associated with prenatal cannabis use.

Introduction

Cannabis is the most prevalent federally illicit drug used in the United States (SAMHSA, 2021). As a growing number of states are legalizing cannabis for medical and/or recreational purposes and access to cannabis is subsequently increasing, rates of cannabis use have been rising, both generally, and among women specifically (Hasin et al., 2019; SAMHSA, 2021). Cannabis potency has also been increasing, with several studies showing increased concentration of the main psychoactive component in cannabis, Δ-9-tetrahydrocannabinol (THC), over recent decades (Chandra et al., 2019; ElSohly et al., 2021; Mehmedic et al., 2010). Additionally, cannabis is also the most used illicit drug in pregnancy, and rates of prenatal use are rising as well, with the highest prevalence rates reported among samples of young, urban, and low-socioeconomic status women (ACOG, 2017; Beatty et al., 2012; Mark et al., 2016; Passey et al., 2014; SAMHSA, 2021; Schempf & Strobino, 2008; Volkow et al., 2019).

Survey and qualitative research have identified motivations for cannabis use during pregnancy. Throughout the literature, one of the primary reasons for prenatal cannabis use is the management of pregnancy-related symptoms, predominantly nausea and vomiting (Barbosa-Leiker et al., 2020; Chang et al., 2019; Daniels et al., 2022; Kiel et al., 2023; Ko et al., 2020; Mark et al., 2017; Young-Wolff, Gali, et al., 2020). Another common reason reported for cannabis use during pregnancy is the relief of psychological difficulties, predominantly stress or anxiety (Barbosa-Leiker et al., 2020; Chang et al., 2019; Daniels et al., 2022; Ko et al., 2020). Additionally, women have also reported using cannabis during pregnancy to manage other medical and physical conditions, such as pain and sleep issues (Barbosa-Leiker et al., 2020; Daniels et al., 2022; Kiel et al., 2023; Ko et al., 2020).

A few meta-analyses have recently examined birth and perinatal outcomes associated with in-utero cannabis exposure (Lo et al., 2022, 2023; Marchand et al., 2022). The Marchand et al. meta-analysis (2022) consisted of 16 studies comparing outcomes of infants who were exposed to cannabis in utero with those who were not exposed, while the Lo et al. meta-analysis (2022) was comprised of 50 studies involving perinatal outcomes of in utero cannabis exposure, including both cohort and case control studies, and the Lo et al. meta-analysis (2023) was updated to include 53 studies. Marchand et al. (2022) found higher rates of adverse neonatal outcomes in those exposed to cannabis in utero compared to those who were not. Likewise, Lo et al. (2022, 2023) reported that prenatal cannabis use was significantly associated with greater odds of adverse birth outcomes. In addition, several studies of longer-term childhood outcomes have consistently found associations between cannabis exposure in utero and a variety of adverse outcomes such as sleep problems, withdrawal symptoms, externalizing problems, psychopathology characteristics, and poor cognitive and educational functioning (Betts et al., 2022; El Marroun et al., 2019; Murnan et al., 2021; Paul et al., 2021; Sharapova et al., 2018; Torres et al., 2020). Yet, one recent systematic review of neuro-behavioral outcomes of prenatal cannabis use found no consistent association between prenatal cannabis exposure and cognitive and intelligence outcomes (Thompson et al., 2023). Several limitations must be considered, however, including co-exposure to other substances, reliance often on self-reports of substance use, and confounding variables such as socioeconomic status (National Academics of Sciences, Engineering, and Medicine et al., 2017).

Research indicates that the perceived risk of prenatal cannabis use has lessened over time (Alshaarawy & Vanderziel, 2022; Jarlenski et al., 2017). In recent qualitative research, women have reported a preference for cannabis because they view it as “safe” and “natural,” compared

to other medications and drugs (Barbosa-Leiker et al., 2020; Chang et al., 2019). Further, women report being more aware of adverse outcomes associated with prenatal use of other substances, such as tobacco, than cannabis (Chang et al., 2019).

While increasing rates of prenatal cannabis use may be related to the liberalization of cannabis regulations and the subsequent increased accessibility of the drug, few studies have assessed women's attitudes and beliefs about cannabis use during pregnancy. According to a recent review, the existing research on attitudes towards cannabis among women of child-bearing age lacks reliable, quantitative measures (Skelton et al., 2022a). In response to the rising prevalence of prenatal cannabis use and the shifting viewpoints of its safety, as well as the lack of a reliable measure on the perceptions of prenatal cannabis use, Dr. Jeanelle Sheeder and colleagues developed a measure of attitudes and beliefs of prenatal cannabis use, the Perceptions of Prenatal Cannabis Use (PPCU) survey. Over the past nine years, the survey has been administered in three different sites with varying laws on cannabis use, which afforded the unique opportunity to look at the survey data more closely, as well as examine the psychometric properties of the survey. The current study analyzed data from the PPCU collected in three different locations (Denver, Pittsburgh, Richmond) across differing time points and with varying levels of cannabis legality. The study's findings will inform the need for future research and education on the outcomes of prenatal cannabis use.

The specific aims and hypotheses of the study are as follows:

Specific Aim 1: Describe the rates of endorsement of various adverse consequences and potential benefits of cannabis use generally, as well as during pregnancy.

Specific aim 2: Examine the reliability and validity of the PPCU survey**.**

Specific aim 3: Describe demographic correlates of perceptions of cannabis use during pregnancy, both within locations and overall.

1) Individuals who are younger (≤25 years) will be more likely to have higher PPCU scores than individuals who are older (>25 years).
2) Individuals who are unmarried will be more likely to have higher PPCU scores than individuals who are married/living as married.
3) Individuals with a lower education level (≤high school/GED) will be more likely to have higher PPCU scores than individuals with a higher education level (>high school/GED).
4) Individuals who self-reported recent cannabis use will be more likely to have higher PPCU scores than individuals who did not self-report recent cannabis use.

Specific aim 4: Explore differences in perceptions of cannabis use across three locations (Denver, Pittsburgh, Richmond), given the differing time points of data collection and status of cannabis legality at time of data collection.

Review of the Literature

Trends in Cannabis Use and Potency

Rates of Cannabis Use

Cannabis is the most prevalent federally illicit drug used in the United States, and it is the most widely used substance in general after tobacco and alcohol (SAMHSA, 2021). Access to cannabis has been increasing as it is becoming legalized for medical and/or recreational purposes in a growing number of states. Currently, 37 states in the U. S. allow for the medical use of cannabis products, with 19 states (and Washington, D. C.) having fully legalized recreational cannabis for adult non-medical use (National Conference of State Legislatures, 2022). Perhaps

due to the liberalization of cannabis regulations and the subsequent increased accessibility of the drug, rates of cannabis use have been rising. Past-year cannabis use among adults in the United States has steadily increased since 2007, having gone from 9.9% in 2007 to 18.7% in 2020, according to the National Survey on Drug Use and Health (NSDUH; SAMHSA, 2021). Rates of lifetime cannabis use among U. S. adults reached 49% in 2020, with 12.4% of the sample reporting use in the past month (SAMHSA, 2021). Looking specifically at women, a review of data from: NSDUH (2002-2014); the National Institute on Alcohol Abuse and Alcoholism (1991-1992; 2001-2002; 2012-2013); and the National Alcohol Survey (1984-2015) found prevalence of cannabis use increased significantly in all three surveys over the time frames specified (Hasin et al., 2019).

Potency of Cannabis

In addition to rising rates of cannabis use, cannabis potency has also been increasing over recent decades (Chandra et al., 2019; ElSohly et al., 2021; Mehmedic et al., 2010). Potency data on 46,211 samples of cannabis preparations confiscated in the United States from 1993 to 2008 found that the main psychoactive ingredient in cannabis, Δ-9-tetrahydrocannabinol (THC), nearly tripled during this period, increasing from 3.4% in 1993 to 8.8% in 2008 (Mehmedic et al., 2010). During the subsequent decade, several studies have demonstrated that THC concentration in cannabis samples has continued to increase (Chandra et al., 2019; ElSohly et al., 2021). An analysis of 18,108 samples of cannabis preparations in the U. S. from 2008-2017 showed that the mean THC concentration rose from 8.9% in 2008 to 17.1% in 2017 (Chandra et al., 2019). Another analysis of 14,234 cannabis samples seized by the Drug Enforcement Agency (DEA) from 2009-2018 showed an increase in mean THC concentration from 9.75% in 2009 to 14.88% in 2018 and 13.88% in 2019 (ElSohly et al., 2021).

Rates of Cannabis Use During Pregnancy

Cannabis is also the most prevalent illicit substance used among pregnant women, and rates of use are increasing as well (ACOG, 2017). Using NSDUH survey data, researchers have compared patterns of cannabis use among pregnant and non-pregnant women as well as changing rates of prenatal use over time (Ko et al., 2015; Volkow et al., 2019). Ko et al. (2015), using 2007-2012 NSDUH data, found that 3.9% of pregnant women self-reported recent (past month) cannabis use, and 7.0% reported use in the past 2-12 months. They also found cannabis use decreased by trimester with past-month rates of use being highest among women in the first trimester (7.4%) and lowest among women in their last trimester (1.8%; Ko et al., 2015). Pregnant women who had used cannabis within the past year were more likely to be 18-25 years of age, unemployed, earning less than $20,000 annually, and never married, compared to non-users, and past-month pregnant cannabis users were also more likely to be uninsured than non-users (Ko et al., 2015). Further, 18.1% of pregnant women who reported cannabis use in the past year met DSM-IV criteria for cannabis abuse and/or dependence, and 16.2% of pregnant past-year cannabis users reported daily cannabis use (Ko et al., 2015). More recently, looking at NSDUH data from 2002-2017, Volkow and colleagues (2019) found that past-month cannabis use, daily/near daily cannabis use, and the number of days of cannabis use all increased among pregnant women aged 12-44 years of age over that period (Volkow et al., 2019). Additionally, in a study of NSDUH data from 2019 to 2020, SAMHSA reported rates of past month cannabis use during pregnancy among women aged 15 to 44 increased from 5.4% in 2019 to 8.0% in 2020 (SAMHSA, 2021). Cannabis use prevalence is also increasing among women presenting to substance use disorder (SUD) treatment. In a national sample of pregnant women admitted to

SUD treatment, Martin et al. (2015) found self-reports of recent cannabis use increased from 29% in 1992 to 43% in 2012 (Martin et al., 2015).

While studies of cannabis use during pregnancy generally report prevalence rates of 2-5%, this number varies depending on sample demographics. Table 1 details prevalence rates of prenatal cannabis use across studies. Overall, among non-clinical samples, rates cluster around 3-5% (El Marroun et al., 2011; Svikis et al., 1997; van Gelder et al., 2010), with higher prevalence (15-34%) among samples of young, urban, low-income, low-socioeconomic status women (Beatty et al., 2012; Mark et al., 2016; Passey et al., 2014; Schempf & Strobino, 2008). Higher prevalence rates of prenatal cannabis use have also been identified in more recent studies (e.g., 34%; Daniels et al., 2022). Rates of prenatal cannabis use may also differ depending on the method of assessment used (e.g., self-report and urinalysis). Self-report measures can assess a broader window of time than biological measures, as biological measures have brief detection windows. However, pregnant women may not self-report their prenatal cannabis use due to factors such as social desirability, forgetfulness, or fear of judgment or legal consequences, in which case, biological methods of assessment may detect positive cases that were not identified by self-report. In a recent review of 12 studies assessing the validity of self-report measures of prenatal cannabis use compared to biological samples, Skelton et al. (2022b) found that self-report data were widely unreliable, and that biometric estimates found higher prevalence rates. However, they did find that self-reports were more valid in populations with current or prior history of drug use (e.g., those in substance use treatment programs) and when assessed via interviews by a research team member as opposed to health care provider screenings or self-administered surveys (Skelton et al., 2022b).

Table 1 also details the methods of assessment used to measure rates of prenatal cannabis use across studies. Overall, rates varied based on the assessment method that was employed. For example, one study (N = 100) found that a total of 14% of pregnant women were positive for cannabis use during the past three weeks, with 10% having screened positive by urine toxicology alone and only 4% having screened positive by both self-report and urine toxicology results (Beatty et al., 2012). Additionally, while 11% self-reported cannabis use during the past three months, over twice as many women (28%) screened positive for cannabis use from analysis of hair samples (Beatty et al., 2012). El Marroun et al. (2011), in a study with N = 3,997 participants, found that while 92 (2.3%) of women reported cannabis use during pregnancy, only 33 of those women provided positive urine screens. Furthermore, 71 women total (1.8%) provided positive urine screens, indicating that there were also women who provided a positive urine screen and did not self-report their use, and that the total percentage of women with some evidence for cannabis use during pregnancy was 3.3% (El Marroun et al., 2011).

Table 1. Studies of Prenatal Cannabis Use Prevalence

Author / Year	Method of Assessment	Time Period of Data Collection	Sample Characteristics	Rates of Prenatal Cannabis Use
van Gelder et al. 2010	Self-report	Oct. 1, 1997-Dec. 31, 2004.	General sample of 5,871 women surveyed post-delivery.	At any point in pregnancy: -3.2%
Schempf & Strobino 2008	Any of 3 measures: urine toxicological screen, self-report, or other documentation in medical record	Feb. 16, 1995-May 31, 1996.	808 low-income women who delivered at Johns Hopkins Hospital surveyed post-delivery. Majority of the sample was aged 19-24 years (52%), Black (94%), and had not received education beyond high school (88%).	At any point in pregnancy: -15%
Passey et al. 2014	Self-report	July-Sept. 2010 & April-June 2011	257 pregnant Indigenous women in Australia surveyed at prenatal visit. Median age of 23 years. Majority (82%) had not completed year 12 at school. Most were in their third trimester (56%), followed by second trimester (35%), then first trimester (8%).	Current use at time of survey: -15%
Mark et al. 2016	Either of 2 measures: self-report or urine toxicology	July 1, 2009-June 30, 2010.	396 patients in the U. S. presenting for prenatal care at an urban, university-affiliated clinic screened at first prenatal visit. Majority of patients were Black (88.6%), not married (82.9%),	At first prenatal visit: -29.3%

			unemployed (68.2%), and had not completed high school (58.5%).	
Beatty et al. 2012	Rates reported separately for 3 methods: -self-report -urine toxicology -analysis of hair samples	Not listed	100 women recruited in the U. S. from a large, urban hospital post-delivery. Majority of the sample was Black (94%), had less than a high school education (72%), and were receiving public assistance (86%).	Past 3 weeks: -14% total (10% by urine toxicology alone; 4% by urine toxicology and self-report) Past 3 months: -34% total (28% by analysis of hair samples; 11% by self-report)
El Marroun et al. 2011	Rates reported separately for 2 methods: -self-report -urine toxicology	Feb. 2004-Nov. 2005	3,997 pregnant women in the Netherlands enrolled during pregnancy, usually in the first trimester.	-3.3% total (by self-report and/or urine toxicology) -2.3% by self-report -1.8% by urine toxicology
Svikis et al. 1997	Self-report	Not listed	92 pregnant women seeking prenatal care at a community-based hospital, surveyed at the first prenatal visit. Mean age of 25.3 years, and the majority were white (67%). 33% were unemployed, 35% were married, and 29% had less than a high school education.	Past 30 days: -5%
Daniels et al. 2022	Self-report	Sept. 2017-Dec. 2017	103 individuals recruited via web-based sampling who reported a current or previous pregnancy. Majority of the sample was aged 30-40 years (60.2%), married/common law (88.3%), and Euro-Canadian (92.2%).	At any point in pregnancy: -34%

Prior research has also demonstrated associations between the legalization, and subsequent retail availability, of cannabis and rates of prenatal cannabis use. Skelton and colleagues (2020) used data from the 2016 Pregnancy Risk Assessment Monitoring System (PRAMS) to compare rates of prenatal cannabis use in three states that had legalized recreational use and three states that had not, and found that women residing in states with legalized recreational use were significantly more likely to use during pregnancy (Skelton et al., 2020a). Another study examined the association between proximity to cannabis retailers and prenatal cannabis use among women in Northern California following the legalization of recreational use

and found that having more cannabis retailers within a 15-minute drive was associated with a higher likelihood of prenatal cannabis use (Young-Wolff, Adams, et al., 2021).

Additionally, rates of biochemically verified cannabis use during pregnancy appear to have increased during the COVID-19 pandemic. A recent study screened 100,005 pregnant women in California for prenatal cannabis use via a urine toxicology test from January 1, 2019, through December 31, 2020 (Young-Wolff, Ray, et al., 2021). The study found an increase in positive urine screens during the COVID-19 pandemic, from 6.75% before the pandemic to 8.14% during the pandemic (Young-Wolff, Ray, et al., 2021). Another study analyzed medical charts at an academic regional medical center and found rates of prenatal cannabis use during the pandemic (June 2020-June 2021) were significantly higher (26%) than those for the period (January 2019-May 2020) prior to the COVID-19-related statewide shutdown (17%; Wentworth et al., 2022).

Reasons for Cannabis Use Among Women

Individuals use cannabis for a variety of reasons, including enjoyment/fun, conformity, experimentation, social enhancement, boredom, and relaxation (Lee et al., 2007). Additionally, people may use cannabis for therapeutic or medical purposes, such as treating pain, sleep, headaches/migraines, appetite, and nausea/vomiting, as well as managing psychological conditions, including anxiety, depression, and PTSD/trauma (Leung et al., 2022; Walsh et al., 2013). Too little attention has focused on sex and gender differences. A recent review of cannabis-related knowledge, attitudes, perceptions, motivations, and influences among women affirmed that the reasons for cannabis use among women remains largely unknown (Skelton et al., 2022a). One study examining sex differences in cannabis use found that generally, women were more likely than men to report using cannabis to treat nausea, anxiety, anorexia, irritable

bowel syndrome, and headaches/migraines (Cuttler et al., 2016).

Reasons For Cannabis Use During Pregnancy

More is known about reasons for cannabis use during pregnancy. Survey research has identified reasons for prenatal cannabis use that include relief of psychological difficulties and improvement of mood; management of chronic, as well as general, medical conditions; management of physical pregnancy-associated symptoms; improvement of sleep and to increase energy; and for recreational purposes (Daniels et al., 2022; Ko et al., 2020; Mark et al., 2017; Young-Wolff, Gali, et al., 2020). While the primary motivation for prenatal cannabis use varies across studies, the treatment of nausea/vomiting and the relief of stress/anxiety are among the most common reasons given (Daniels et al., 2022; Ko et al., 2020; Mark et al., 2017; Young-Wolff, Gali, et al., 2020). Additionally, qualitative research has yielded similar findings, with treatment of pregnancy-related symptoms and other physical illnesses, management of psychological difficulties and improvement in mood, and to help with parenting struggles as the most common reasons for cannabis use (Barbosa-Leiker et al., 2020; Chang et al., 2019).

Most Common Reasons: Treatment of Nausea and Vomiting and Relief of Stress and Anxiety

Mechanisms of Cannabis: Treating Nausea/Vomiting and Relieving Stress/Anxiety. In a review of the literature, Parker et al. (2011) highlighted substantial evidence demonstrating that the manipulation of the endocannabinoid system regulates nausea and vomiting among humans and other animals. Research shows that at lower doses, Δ_9-THC acts centrally as an anti-emetic by activating CB_1 receptors, which suppresses vomiting (Parker et al., 2011). A recent study measuring the real-time effects of cannabis-based products on nausea in a sample of 886 people found that 96.4% of people experienced symptom relief, with statistically significant levels of relief occurring within five minutes (Stith et al., 2022). Further, medical cannabis has

been FDA-approved for chemotherapy-induced nausea and vomiting (Levinsohn & Hill, 2020). However, the FDA strongly advises against the use of cannabis in any form during pregnancy (U. S. Food & Drug Administration, 2019).

Cannabis can also modulate anxiety and mood by acting on specific regions of the brain, including the medial prefrontal cortex, amygdaloid complex, bed nucleus of stria terminalis, and hippocampus (Sarris et al., 2020). The various interactions of THC and CBD with the endocannabinoid system have connected them with emotion regulation and anxiety management (Van Ameringen et al., 2020). In a recent narrative review of the literature on cannabis as a potential treatment for anxiety, Stack et al. (2022) reported the current research on the effectiveness of cannabis constituents, such as THC and cannabidiol (CBD), on the treatment of anxiety, although overall, they indicated that more research is needed. While research has shown that THC can cause anxiety at high doses, some studies have also found anxiolytic effects of THC at low doses, likely due to binding at CB1Rs in the limbic regions of the brain (Stack et al., 2022). Both human and animal studies have demonstrated the anxiolytic effects of CBD, although the exact mechanism is still widely unknown (Stack et al., 2022).

Associations of Prenatal Cannabis Use and Nausea/Vomiting. Higher rates of cannabis use have been found among pregnant women experiencing nausea and vomiting compared to those who do not (Roberson et al., 2014; Young-Wolff et al., 2018), indicating the potential use of cannabis as self-medication for the nausea and morning sickness associated with pregnancy. A study of 4,735 women with recent live births in Hawaii found that women who reported experiencing severe nausea during pregnancy were significantly more likely to use cannabis than women who did not report severe nausea during pregnancy (Roberson et al., 2014). Another study analyzing California health care system records for 279,457 pregnant

women screened from 2009 to 2016 found that those who experienced mild or severe nausea and vomiting in pregnancy had increased odds of cannabis use during pregnancy compared to women with no perinatal nausea and vomiting (Young-Wolff et al., 2018). While this may indicate prenatal cannabis use as self-treatment for nausea and vomiting in pregnancy, studies assessing the association between cannabis and nausea/vomiting in pregnant women have all been correlational, so the directionality of the association is not entirely clear in this population.

Associations of Prenatal Cannabis Use and Stress/Anxiety. Research shows that depression, anxiety, and trauma are also all associated with prenatal cannabis use (Meinhofer et al., 2022; Murnan et al., 2021; Skelton & Benjamin-Neelon, 2021; Young-Wolff, Sarovar, et al., 2020). In a sample of pregnant women from 2012-2017, depressive and anxiety disorders and trauma diagnoses were ascertained from patients' electronic medical records (Young-Wolff, Sarovar, et al., 2020). Results showed that depression, anxiety, and trauma were all associated with higher odds of prenatal cannabis use (Young-Wolff, Sarovar, et al., 2020). Likewise, among women receiving prenatal care at a university-based health center, women who continued cannabis use during pregnancy were significantly more likely to have elevated depression and anxiety scores than those with no cannabis use (Mark et al., 2021). Additionally, in an analysis of 2018 PRAMS data, women who reported prenatal depression and anxiety were significantly more likely to also report prenatal cannabis use (Skelton & Benjamin-Neelon, 2021). Similarly, a study of hospital discharge data across 35 states from 2010 to 2018 found that pregnant patients with cannabis use disorder had elevations in depression and anxiety compared to those with no substance use disorders (Meinhofer et al., 2022).

Self-Reports of Prenatal Cannabis Use to Manage Nausea/Vomiting and Stress/Anxiety. Multiple studies have shown that women directly report the use of cannabis to

manage pregnancy-associated physical symptoms, predominantly nausea and vomiting, as well as psychological difficulties, such as stress or anxiety (Barbosa-Leiker et al., 2020; Chang et al., 2019; Daniels et al., 2022; Kiel et al., 2023; Ko et al., 2020; Mark et al., 2017; Young-Wolff, Gali, et al., 2020). In a sample of 306 pregnant women attending a prenatal visit at a university medical center in Baltimore between 2015 and 2016, women who used cannabis throughout their pregnancy were asked about factors contributing to their continued use. Nearly all (96%) of the sample reported treatment of nausea as their primary motivation (Mark et al., 2017). Similarly, analysis of data from semi-structured interviews with 25 women who had either disclosed cannabis use or tested positive at a prenatal visit found the treatment of pregnancy-related nausea, vomiting, or appetite changes among the primary reasons for use, as well as the management of stress and improvement of mood (Chang et al., 2019). In a Washington state sample of women who continued to use cannabis throughout pregnancy, common reasons for prenatal cannabis use were health management for one or more physical issues, including morning sickness and nausea, and the management of stress, anxiety, and trauma (Barbosa-Leiker et al., 2020). An anonymous online study of perinatal cannabis use also found the most common reason for cannabis use during pregnancy was to increase appetite or reduce nausea (Young-Wolff, Gali, et al., 2020). While only a few posts on the digital health platform (6.6%) included reasons for prenatal cannabis use, almost half of such posts (3.0%) stated the reason as increasing appetite or reducing nausea (Young-Wolff, Gali, et al., 2020). In an online survey study of individuals who reported a current or previous pregnancy, among those who reported using cannabis during pregnancy, the most common reason for prenatal cannabis use was morning sickness, followed by nausea and appetite (Daniels et al., 2022). Additionally, in qualitative interviews with women in Washington state who used cannabis during pregnancy,

participants reported the management of nausea and morning sickness among their reasons for use (Kiel et al., 2023). Finally, a recent Centers for Disease Control and Prevention (CDC) study of the 2017 PRAMS data from eight states found that the relief of stress and anxiety was the most common reason for prenatal cannabis use (81.5%), followed by the relief of nausea or vomiting (77.8%; Ko et al., 2020).

Other Reasons for Use

In addition to managing nausea/vomiting and stress/anxiety, women have reported using cannabis during pregnancy to manage other conditions (Barbosa-Leiker et al., 2020; Daniels et al., 2022; Kiel et al., 2023; Ko et al., 2020). In the analysis of the 2017 PRAMS data, participants reported using cannabis to relieve pain (55.1%) and relieve the symptoms of a chronic condition (24.9%; Ko et al., 2020). Similarly, one Washington state study also found that women included health management for a variety of physical issues, including weight gain, pain, and sleep, among their reasons for prenatal cannabis use (Barbosa-Leiker et al., 2020). Additionally, in the online survey study of individuals who were currently or previously pregnant, participants also reported using cannabis for pain and insomnia (Daniels et al., 2022). Participants in the Washington state qualitative study also reported using cannabis during pregnancy to help manage pain (Kiel et al., 2023). Other reasons reported in the literature for prenatal cannabis use include to have fun or relax, to deal with the stress and physical toll of parenting, and to better communicate on a child's level (Barbosa-Leiker et al., 2020; Ko et al., 2020).

Changes in Motivations for Cannabis Use Before and During Pregnancy

A few studies have assessed changes in motivations for cannabis use before, during, and after pregnancy (Skelton et al., 2020b; Vanstone et al., 2021). In a unique study that looked at reasons for cannabis use both pre-pregnancy and during the perinatal period among Canadian

pregnant people who used cannabis, the most common reason for use in the months prior to pregnancy was sensation-seeking (e.g., recreational use to experience a desired high), followed by symptom management (e.g., "therapeutic" use), followed by coping with difficult or unpleasant aspects of life (e.g., improving sleep quality, relaxing, stress management; Vanstone et al., 2021). However, during pregnancy, reasons for cannabis use changed, and the most common reason for continued use was symptom management, predominantly to manage nausea and vomiting, followed by coping (Vanstone et al., 2021). Similarly, a study analyzing 2016 and 2017 PRAMS data specifically for New Hampshire found that both during the preconception and postpartum periods, the most common reason for cannabis use was to relieve stress or anxiety, yet during pregnancy, the most common reason for cannabis use was to treat nausea and vomiting (Skelton et al., 2020b). Women in this study also reported less prominent reasons for prenatal cannabis use, including increasing appetite, aiding sleep, and helping with pain, depression, and post-traumatic stress disorder (Skelton et al., 2020b).

Outcomes of Prenatal Cannabis Use

While data on the outcomes of prenatal cannabis use have historically been inconsistent, two recent meta-analyses have examined birth and perinatal outcomes associated with in-utero cannabis exposure (Lo et al., 2022; Marchand et al., 2022). In the largest meta-analysis on this topic to date, Marchand and colleagues (2022) analyzed 16 studies including 59,138 participants comparing neonatal outcomes of infants who were exposed to cannabis in utero with those who were not exposed. They found that there were significant increases in seven adverse neonatal outcomes in those exposed to cannabis in utero compared to those who were not, including increased risk of low birth weight, small for gestational age, preterm delivery, and NICU admission; and decreased mean birth weight, Apgar score at one minute, and infant head

circumference (Marchand et al., 2022). This systematic review and meta-analysis contains various strengths and weaknesses. As pointed out by Skelton and Benjamin-Neelon (2022), the size of this meta-analysis on this specific topic is considerable and given the increased potency of THC in cannabis products over recent decades, it is also a notable strength that this meta-analysis contained ten studies that were published in 2015 or later (Skelton & Benjamin-Neelon, 2022). However, as noted by the authors of the meta-analysis, many of the included studies did not differentiate levels or variability of cannabis exposure (e.g., mode, frequency, method of cannabis consumption), restricting the ability to determine if there are safe(r) doses or methods of administration (Marchand et al., 2022). The authors also pointed out that the majority of included studies relied, as least partially, on participants' self-report of cannabis use during pregnancy, which may be subject to forgetfulness or social desirability bias (Marchand et al., 2022). Additionally, as noted by Skelton and Benjamin-Neelon (2022), the authors did not adjust for co-exposure to tobacco in their analyses, which may impact the generalizability of their findings. The meta-analysis by Marchand and colleagues also only assessed birth outcomes, as opposed to also looking at potential longer-term consequences of exposure to cannabis in utero.

Another recent systematic review and meta-analysis by Lo and colleagues (2022) included both cohort and case control studies involving perinatal outcomes of in utero cannabis exposure. This meta-analysis included 50 studies, and unadjusted data found that prenatal cannabis use was significantly associated with greater odds of preterm birth, low birth weight, small for gestational age, and perinatal death (Lo et al., 2022). However, when adjusting for multiple factors including tobacco use, prenatal cannabis use remained significantly associated with greater odds of preterm birth and small for gestational age, but was no longer significantly associated with low birth weight, and a summary estimate for perinatal death was not able to be

calculated due to insufficient data (Lo et al., 2022). Yet, a more updated systematic review and meta-analysis by Lo and colleagues (2023) including 53 studies found that prenatal cannabis use was significantly associated with greater odds of preterm birth, small for gestational age, and perinatal mortality even after accounting for prenatal tobacco use (Lo et al., 2023). A strength of the Lo et al. meta-analyses, compared to the Marchand et al. study, was that they conducted adjusted analyses to account for the common co-exposure of tobacco use. However, unlike the Marchland et al. analyses, Lo and colleagues included cohort studies that did not contain control participants who had not been exposed to cannabis in utero.

While the two aforementioned meta-analyses examined birth and neonatal outcomes associated with prenatal cannabis use, several studies have also examined longer-term childhood outcomes (Betts et al., 2022; El Marroun et al., 2019; Murnan et al., 2021; Paul et al., 2021). One such study analyzed data from a prospective prenatal cohort in the U. S., comparing children who had been exposed to cannabis in utero with those who had not, and found that exposed children had more sleep-related problems, withdrawal symptoms, and externalizing problems at age 3.5 years (Murnan et al., 2021). A different study analyzing data from the longitudinal Adolescent Brain and Cognitive Development Study found that compared to no exposure, prenatal cannabis exposure was associated with greater offspring psychopathology characteristics, sleep problems, and body mass index, and lower gray matter volume and cognition during middle childhood (Paul et al., 2021). Another study assessing perinatal data in Australia from 2003 to 2005 also found associations between prenatal cannabis exposure and cognitive outcomes, showing that in unadjusted analyses, prenatal cannabis use disorder was associated with an increased risk of not meeting national minimum standards of education outcomes in primary and secondary school (Betts et al., 2022). However, after exact matching by

covariates, the associations attenuated greatly, indicating that socio-economic status plays a confounding role in the association between prenatal cannabis exposure and poor educational outcomes (Betts et al., 2022). Similarly, analyses of a population-based cohort study in the Netherlands found that confounding variables likely explained the association they found between prenatal cannabis exposure and childhood outcomes (El Marroun et al., 2019). While this study found that prenatal cannabis use was associated with offspring externalizing problems, maternal cannabis use before pregnancy and cannabis use by the father were also associated with child externalizing problems (El Marroun et al., 2019).

A few systematic reviews have also assessed the potential cognitive and neuropsychological effects of prenatal cannabis use (Sharapova et al., 2018; Torres et al., 2020). Sharapova and colleagues assessed 21 studies on neuropsychological outcomes in 1–11-year-old children who had been exposed to cannabis in utero (Sharapova et al., 2018). Their findings indicated that among these studies, associations were found between prenatal cannabis exposure and decreased performance on memory, impulse control, problem-solving, quantitative reasoning, verbal development, and visual analysis tests; as well as increased performance on attention and global motion perception tests (Sharapova et al., 2018). However, the authors note that there were limitations in their review, including participants' co-use of other substances, potential underreporting of prenatal cannabis use, and publication bias, which may have led to an overestimation of effects due to the possible selective publication of results (Sharapova et al., 2018). Another more recent systematic and critical review of the literature on impacts of prenatal cannabis exposure on cognitive functioning found that children exposed to cannabis in-utero overwhelmingly fell in the normal range on cognitive performance tasks, indicating that there are not clinically significant findings of the impact of in-utero cannabis exposure on cognitive

abilities (Torres et al., 2020). However, in a published commentary, Singer et al. (2021) questioned the methodological approaches of this review, primarily due to the inclusion of several studies that were conducted with the intention of studying effects of prenatal cocaine exposure, not prenatal cannabis exposure (Singer et al., 2021). Although, an even more recent systematic review of the impact of prenatal cannabis exposure on offspring neuro-behavioral outcomes found no consistent association between prenatal cannabis exposure and cognitive function and intelligence (Thompson et al., 2023).

Given the complications of determining the outcomes of prenatal cannabis use, pregnant people struggle to understand the safety and potential risks of prenatal cannabis use. Several studies have demonstrated that pregnant individuals receive insufficient information and inconsistent messages from their healthcare providers when discussing prenatal cannabis use (Barbosa-Leiker et al., 2020; Holland et al., 2016; Jarlenski et al., 2016; Woodruff et al., 2021; Young-Wolff, Gali, et al., 2020). Additionally, many women do not even report their prenatal cannabis use to their healthcare providers, due to a fear of judgment and/or legal ramifications, which may further limit their ability to access accurate information (Woodruff et al., 2021). Accordingly, pregnant people may turn to other, potentially less reliable, sources for information on prenatal cannabis use, such as their friends and family, the Internet, and dispensary employees (Dickson et al., 2018; Jarlenski et al., 2016; Kiel et al., 2023; Woodruff et al., 2021; Young-Wolff et al., 2022). These complexities in accessing reliable information may potentially impact their perceptions of the safety of prenatal cannabis use.

Perceptions of Cannabis Use During Pregnancy

In recent studies, women report perceiving cannabis as safer to use during pregnancy than other substances, including both recreational drugs and prescription medications (Barbosa-Leiker

et al., 2020; Chang et al., 2019), and some research indicates that the perceived risk of prenatal cannabis use has lessened over time (Alshaarawy & Vanderziel, 2022; Jarlenski et al., 2017). In a study analyzing NSDUH data from 2005 to 2015, the rate of reporting no risk of cannabis use among pregnant women increased from 3.5% to 16.5%, and among pregnant women who reported cannabis use in the past 30 days, the rate increased from 25.8% to 65.4% (Jarlenski et al., 2017). Additionally, a study examining cannabis risk perceptions among pregnant people in the U.S. utilizing NSDUH data from 2002-2019 found that there was a sharp decline in the percentage of pregnant people that perceived using cannabis 1-2 times per week as a great risk after 2008 (Alshaarawy & Vanderziel, 2022). In line with shifting views of the risk of prenatal cannabis use over time, a study from 2012 found that when 50 women recruited from their private hospital room in the U. S. after giving birth were asked about the perceived risk of using alcohol, tobacco, and cannabis during pregnancy, the women rated all three substances as highly dangerous to use during pregnancy (Beatty et al., 2012). However, other results from this study also indicate that the women did not perceive cannabis as being as harmful during pregnancy as other substances; when asked to select the substance most likely to harm the baby if used during pregnancy, most women chose alcohol, followed by tobacco, and only one participant chose cannabis (Beatty et al., 2012). Furthermore, significantly more women were willing to report a safe amount of cannabis to use during pregnancy (e.g., half a joint, one joint, two to three joints) than tobacco, and 76% reported knowing people who felt that cannabis use during pregnancy was not very dangerous for the baby (Beatty et al., 2012). Another study analyzing 2007-2012 NSDUH data found similarly high rates of little to no perceived risk of cannabis use during pregnancy (Ko et al., 2015). Among women who had used cannabis in the past year, almost 70% of pregnant women perceived slight or no risk of harm from using cannabis once a month or

once or twice in one week (Ko et al., 2015). In a study from a few years later, women also indicated that they would be more likely to use cannabis during pregnancy if it was legal (Mark et al., 2017). In a sample of 306 pregnant women attending a prenatal visit at a university medical center in Baltimore between 2015 and 2016, 10% of all women and 17% of women with a personal history of cannabis use reported that they would use cannabis during pregnancy if it was legal, and 62% of women who continued cannabis use during pregnancy reported that they would increase their use during pregnancy if it were legalized (Mark et al., 2017). In the same study, women who continued to use cannabis during pregnancy were significantly less likely than women who quit to believe that cannabis use could be harmful during pregnancy (26% vs 75%; Mark et al., 2017). In a more recent study of focus groups of pregnant women in California in 2021, participants also endorsed the impact of legalization on prenatal cannabis use, stating that cannabis use among their pregnant family members and friends had increased in recent years, partially due to the increased access to cannabis that accompanied legalization (Young-Wolff et al., 2022). Further, most of the women reported perceiving a reduction in stigma associated with cannabis use during pregnancy since it had been legalized, and many of them believed that this contributed to an increase in prenatal cannabis use (Young-Wolff et al., 2022). Women also indicated that a benefit of legalization was that it led them to feel more comfortable discussing their prenatal cannabis use with their healthcare providers (Young-Wolff et al., 2022).

In a more recent study, women who were positive for cannabis use at a prenatal visit reported a preference for cannabis because it is "natural," as opposed to prescribed medications containing "chemicals," for the treatment of conditions such as nausea in pregnancy and depression (Chang et al., 2019). These participants also described cannabis as "safe" and "harmless," reporting that since it is "a plant" and "grows from the earth," it seems less harmful

than other recreational drugs (Chang et al., 2019). Some participants expressed the perspective that they do not consider cannabis to be a drug for these reasons (Chang et al., 2019). Additionally, women have reported a familiarity with risk of tobacco use during pregnancy, but not cannabis use. Women who were positive for cannabis use at a prenatal visit reported that they were familiar with negative outcomes associated with tobacco use during pregnancy, but they reported being unaware of any specific risks associated with prenatal cannabis use (Chang et al., 2019). In another recent study, women in Washington who used cannabis daily during pregnancy reported perceiving cannabis as a safer option, compared to other medications, such as opioids, nonsteroidal anti-inflammatory drugs, and anti-nausea medications (Barbosa-Leiker et al., 2020). Relatedly, Daniels et al. (2022) found that women were substituting cannabis during pregnancy for other substances, as two-thirds of the women in their online survey who reported prenatal cannabis use stated that they were substituting cannabis for other pharmaceutical medications, and almost one-quarter reported substituting cannabis for alcohol, tobacco, or other drugs.

Statement of the Problem

Cannabis is the most used federally illicit drug in the United States, both generally and during pregnancy (SAMHSA, 2021; ACOG, 2017). As states continue to legalize cannabis to varying degrees and access to cannabis subsequently increases, rates of use have been rising generally and during the prenatal period (SAMHSA, 2021; Volkow et al., 2019). Throughout the literature, survey and qualitative studies have shown that the most common reasons reported for cannabis use during pregnancy are the treatment of nausea and vomiting and the management of stress and anxiety (Barbosa-Leiker et al., 2020; Chang et al., 2019; Daniels et al., 2022; Kiel et al., 2023; Ko et al., 2020; Mark et al., 2017; Young-Wolff, Gali, et al., 2020). Yet, despite

increasing rates of cannabis use during pregnancy, numerous studies have demonstrated an association between in utero cannabis exposure and adverse birth and childhood outcomes (Betts et al., 2022; El Marroun et al., 2019; Lo et al., 2022, 2023; Marchand et al., 2022; Murnan et al., 2021; Paul et al., 2021; Sharapova et al., 2018; Torres et al., 2020). Studies on the effects of prenatal cannabis use contain several limitations, however, including co-exposure of other substances, reliance on self-reported substance use, and confounding variables such as socioeconomic status (National Academics of Sciences, Engineering, and Medicine et al., 2017). Research has also indicated that the perceived risk of prenatal cannabis use has lessened over time, and that some women report a preference for cannabis because they view is as "safe" and "natural," compared to other substances (Alshaarawy & Vanderziel, 2022; Barbosa-Leiker et al., 2020; Chang et al., 2019; Jarlenski et al., 2017).

While rates of prenatal cannabis use are increasing, few studies have assessed women's perceptions about cannabis use during pregnancy. In response to the lack of a reliable measure on the perceptions of prenatal cannabis use, as well as the rising prevalence of prenatal cannabis use and shifting viewpoints on its safety, Dr. Jeanelle Sheeder and colleagues developed the PPCU survey based on their clinical experiences and knowledge. This survey has been used by members of their group in Denver, members of a research team in Pittsburgh, and most recently, by our research team in Richmond in a study of perinatal substance use. Prior to this study, survey results had not been systematically examined, nor had comparisons been made between the three sites. Additionally, until this study, no psychometric testing of the survey had been conducted. The current study analyzed data from the PPCU survey collected in three different locations (Denver, Pittsburgh, Richmond) across differing time points and with varying levels of cannabis legality. The current study's findings 1) establish psychometric properties of the scale

and 2) inform the need for future research and education on the outcomes of prenatal cannabis use.

The specific aims and hypotheses of the study are as follows:

Specific Aim 1: Describe the rates of endorsement of various adverse consequences and potential benefits of cannabis use generally, as well as during pregnancy.

Specific aim 2: Examine the reliability and validity of the PPCU survey**.**

Specific aim 3: Describe demographic correlates of perceptions of cannabis use during pregnancy, both within locations and overall.

1) Individuals who are younger (≤25 years) will be more likely to have higher PPCU scores than individuals who are older (>25 years).
2) Individuals who are unmarried will be more likely to have higher PPCUS scores than individuals who are married/living as married.
3) Individuals with a lower education level (≤high school/GED) will be more likely to have higher PPCU scores than individuals with a higher education level (>high school/GED).
4) Individuals who self-reported recent cannabis use will be more likely to have higher PPCU scores than individuals who did not self-report recent cannabis use.

Specific aim 4: Explore differences in perceptions of cannabis use across three locations (Denver, Pittsburgh, Richmond), given the differing time points of data collection and status of cannabis legality at time of data collection.

Methods

Participants

In this secondary data analytic study, participants are women who completed an anonymous survey assessing attitudes and beliefs regarding cannabis use, during pregnancy and generally. Participants in the data set were recruited from three different locations: the University of Colorado Hospital (UCH) prenatal clinic in Denver, Colorado (N = 103); the Magee Women's Hospital of University of Pittsburgh Medical Center (UPMC) outpatient OB/GYN clinic in Pittsburgh, Pennsylvania (N = 279); and the Virginia Commonwealth University Health System (VCUHS) postpartum unit in Richmond, Virginia (N = 200).

UCH Participants. Participants were (N = 103) women seeking care at the University of Colorado Hospital prenatal clinic who completed an anonymous paper survey. Women met inclusion criteria if they were at least 18 years of age and were able to read English. The study was approved by the Colorado Multiple Institutional Review Board under "Understanding Women's Beliefs and Attitudes about Marijuana," protocol number 14-2007, and all participants provided informed consent.

UPMC Participants. Participants were (N = 279) individuals who self-identified as female and completed an anonymous paper survey. Recruitment took place in the waiting room of an outpatient obstetrics and gynecology clinic. The majority of participants were patients of the clinic. This was not required, however, and women who were present in the clinic waiting room for other reasons (e.g., accompanying a patient) were also eligible for the study. Women met inclusion criteria if they were at least 18 years of age and were able to read English. The study was approved by the University of Pittsburgh's Institutional Review Board under "Assessing Attitudes and Beliefs About Marijuana," protocol number PRO14010553, and all participants provided informed consent.

VCUHS Participants. Participants were (N = 200) postpartum women who completed a tablet-administered anonymous survey. Women met inclusion criteria if they were new mothers who were at least 18 years of age, were able to read English, were admitted to the postpartum unit at VCUHS, and had slept after giving birth. Women were ineligible if they were cognitively/psychologically unable to provide informed consent or if they were distressed about the health of their newborns. The study was approved by Virginia Commonwealth University's Institutional Review Board under "Cannabis Use in the Perinatal Period," protocol number HM20019023. All participants provided informed consent.

Design and Procedures

UCH Design and Procedures. Participants were enrolled from January 26, 2015, to September 16, 2015. Trained study staff set up materials in the waiting area of the prenatal clinic to recruit clinic patients. Participants who were interested and eligible were invited to complete a 5–10-minute anonymous paper survey assessing attitudes and beliefs about cannabis and cannabis use. Participants did not receive compensation for their participation.

UPMC Design and Procedures. Participants were enrolled during the first recruitment period from December 5, 2013, to July 14, 2015, and during the second recruitment period from July 18, 2018, to August 6, 2019. Female patients were recruited in the outpatient clinics at McGee Women's Hospital of UPMC. Trained research staff set up a table in the waiting area of the outpatient clinics with information about the survey study so that clinic patients and other women present in the waiting area could approach the table if interested. Participants who were interested and eligible were invited to complete a 5–10-minute anonymous paper survey about attitudes and beliefs toward cannabis and cannabis use. Participants were then provided with a

clipboard with a blank survey, envelope, and a pen. Women were given candy as a thank you for their time after completing the survey.

VCUHS Design and Procedures. Participants were enrolled from May 5, 2021, to July 8, 2022. New mothers were recruited from the 20-bed postpartum unit at VCUHS. Women were approached by trained study staff and invited to complete a 15-20-minute iPad-administered demographic and health history survey that included questions about their substance use. Women who met eligibility criteria and wished to participate were instructed on how to use the iPad to complete the survey. Participants were compensated with a $20-$35 gift card upon completing the survey. Participants who completed the survey were part of a larger study (UMATTeR). Subsequent to the survey, they were separately invited to provide anonymous urine and breast milk samples. They also were asked about completing an additional survey on their mood and maternal attachment, with an opportunity to participate in an fMRI imaging study several weeks later. Since these components were only offered after survey completion with separate consent forms, no further information is included herein, as they are not part of the current study.

Measures

At all three locations (Richmond, Pittsburgh, Denver), participants completed a measure assessing their attitudes and beliefs about cannabis use, both generally and during the perinatal period. Participants also provided standard demographic information, including age, race, ethnicity, marital status, and education. The measure on attitudes and beliefs about cannabis use (generally and during the perinatal period) was developed by Dr. Jeanelle Sheeder and colleagues in response to their clinical experiences with patients. Participants were provided with response options on a five-point Likert scale from “strongly agree” to “strongly disagree,” or “don’t know/no opinion” for each statement about cannabis use. The measure contained a set of

standard survey items administered at all three location sites. This standard set of survey items included 13 items about cannabis use generally, including beliefs towards side effects of cannabis use and its ability to treat conditions such as headaches and anxiety, as well as 16 items about cannabis use during pregnancy, including broad statements about the safety of cannabis use during pregnancy, as well as more specific items about whether prenatal cannabis use could lead to in utero chemical exposure. Some recruitment sites included additional items. Table 2 details the survey items that were included at each recruitment site regarding general cannabis use. Table 3 details the survey items that were included at each recruitment site regarding cannabis use during pregnancy.

Table 2. Survey Items Included at Each Recruitment Site Regarding General Cannabis Use

Item	Denver	Pittsburgh	Richmond
Marijuana has no negative side effects.	✓	✓	✓
Marijuana is a natural herb.	✓	✓	✓
Marijuana makes people think slower.	✓	✓	✓
Marijuana makes people feel sad or depressed.	✓	✓	✓
Marijuana is not a real drug.		✓	✓
Marijuana helps with stress.	✓	✓	✓
Marijuana is healthier than cigarettes.	✓	✓	✓
Marijuana takes away aches and pains.	✓	✓	✓
Marijuana is addictive.	✓	✓	✓
Marijuana helps with headaches.	✓	✓	✓
Marijuana takes pain away.	✓	✓	✓
Marijuana is not a real drug because it's made of natural substances.	✓	✓	✓
Marijuana helps with anxiety.	✓	✓	✓
Marijuana has negative side effects.	✓	✓	✓
Marijuana should be legalized.		✓	✓

Table 3. Survey Items Included at Each Recruitment Site Regarding Cannabis Use During Pregnancy

Item	Denver	Pittsburgh	Richmond
Marijuana use during pregnancy can lead to a smaller baby.	✓	✓	✓
Marijuana can reach the baby through the placenta if used during pregnancy.	✓	✓	✓
Marijuana during pregnancy can affect the brain of the baby.	✓	✓	✓
Marijuana use during pregnancy can affect the baby's development.	✓	✓	✓
Marijuana use during pregnancy can block nutrients from reaching the baby.	✓	✓	✓
Marijuana use during pregnancy can lower mom's blood pressure which is good for the baby.	✓	✓	✓
Marijuana use during pregnancy can lead to a larger baby.	✓	✓	✓
Marijuana use during pregnancy can expose the baby to chemicals.	✓	✓	✓
Marijuana use during pregnancy can give the baby breathing problems in the future.	✓	✓	✓
Marijuana use during pregnancy can make the baby addicted to it in the future.	✓	✓	✓
Marijuana has not been proven to be dangerous during pregnancy for either mother or child.	✓	✓	✓
Marijuana helps alleviate or block common feelings of depression during pregnancy.	✓	✓	✓
Marijuana is not safe to use during pregnancy.		✓	✓
Marijuana helps with morning sickness and nausea during pregnancy.	✓	✓	✓
Marijuana increases the mother's appetite during pregnancy.	✓	✓	✓

Marijuana helps keep food down during pregnancy.	✓	✓	✓
Marijuana is ok to use during pregnancy.	✓	✓	✓
Marijuana use during pregnancy (or postpartum) can affect the mother's ability to attach or bond with her baby.			✓ - in new version
The legalization of marijuana will increase use among pregnant women.			✓ - in new version
Marijuana can affect a baby if it is in the breast milk.	✓		✓ - in new version
Marijuana helps reduce stress in pregnancy.	✓		
Marijuana can cross into a mother's breast milk.	✓		
Using marijuana is safer than drinking alcohol during pregnancy.	✓		
Smoking marijuana is safer than smoking cigarettes during pregnancy.	✓		
Marijuana edibles are safer than smoking marijuana during pregnancy.	✓		
Marijuana in pill form is safer than smoking marijuana during pregnancy.	✓		
Vaporized marijuana is safer than smoking marijuana during pregnancy.	✓		
Using marijuana through the skin (like oils or patch) is safer than smoking marijuana during pregnancy.	✓		
Marijuana in any form is not safe to use during pregnancy.	✓		

UCH Measures. Participants completed a 39-item measure assessing their attitudes towards cannabis use. In addition to the 16 standard questions about prenatal cannabis use, women also responded to an additional ten items assessing the perceived safety and effects of

using cannabis while breastfeeding, the perceived safety of cannabis use during pregnancy as compared to alcohol use and cigarette use, the perceived safety of various modes of cannabis use during pregnancy, and whether cannabis use during pregnancy reduces stress. Participants also responded to the 13 standard questions about general cannabis use. In addition to the standard demographic questions, participants provided information on gravidity and parity, pregnancy status, and current cannabis use.

UPMC Measures. Participants completed a 32-item measure assessing their attitudes towards cannabis use. In addition to the 16 standard questions about prenatal cannabis use, women also answered an additional question about whether cannabis is generally safe to use during pregnancy. Then, in addition to the 13 standard questions about general cannabis use, participants responded to an additional two questions about whether cannabis is a real drug and whether it should be legalized. In addition to the standard demographic questions, participants provided information on gravidity and parity and pregnancy status.

VCUHS Measures. All participants completed a 32-item measure assessing their attitudes towards cannabis use. In addition to the 16 standard questions about prenatal cannabis use, women also answered an additional question about whether cannabis is generally safe to use during pregnancy. Then, in addition to the 13 standard questions about general cannabis use, participants responded to an additional two questions about whether cannabis is a real drug and whether it should be legalized. Almost a year into recruitment, the order of administration of these two measures switched due to an IRB amendment of the parent study. Additionally, at the time of this IRB amendment, three additional questions were added to the survey on cannabis use during pregnancy, including whether cannabis can affect maternal attachment, whether the legalization of cannabis will increase use among pregnant women, and whether cannabis can

affect the baby if it is in the breast milk. In addition to the standard demographic questions, participants provided information on their living situation. After the IRB amendment, participants also provided information on gravidity and parity. While not assessed for the purposes of this current proposed study, in this baseline survey of the parent study, participants also provided information regarding their pregnancy, plans to breastfeed, use of tobacco, cannabis, alcohol, and other substances, and attitudes and beliefs about tobacco use (both generally and during the perinatal period).

Variables

Measure of Perceptions of Prenatal Cannabis Use (PPCU) Score. For the PPCU survey, participants were provided with response options on a five-point Likert scale from "strongly agree" to "strongly disagree," or "don't know/no opinion" for each statement about prenatal cannabis use. A total score was generated for this measure for each participant by coding responses for each item 1-5 based on whether the response favored the safety/benefits of prenatal cannabis use (with higher scores favoring the safety/benefits of prenatal cannabis use), summing individual item scores, and then dividing by the number of answered questions. Some items were reverse coded. Responses of "don't know/no opinion" were analyzed separately using univariate analyses.

Age. For the purposes of data analyses, the variable of age was dichotomized as ≤25 years and >25 years of age.

Marital Status. For the purposes of data analyses, the variable of marital status was dichotomized as married/living as married and unmarried. Given the varying available response options for marital status among the three different location sites, responses of married; living with a partner; living with a same sex partner; and married/living as married (5+ years together)

were all coded as married/living as married. Responses of single/never married; divorced; separated; and widowed were coded as unmarried.

Education. For the purposes of data analyses, the variable of highest level of education was dichotomized as ≤high school graduate/GED and >high school graduate/GED.

Recent Cannabis Use. Two of the location sites (Denver and Richmond) asked about recent cannabis use. For the purposes of data analyses, the variable of recent cannabis use was dichotomized as yes/no. The survey administered in Denver asked, "Are you currently using marijuana?" with response options of "Yes, multiple times a day"; "Yes, daily"; "Yes, occasionally (<daily)"; "Not since I've been pregnant but at least once in the 6 months before I got pregnant"; and "No." Any responses containing yes was coded as yes, and any other responses were coded as no. The survey administered in Richmond asked about cannabis use during pregnancy by trimester. Any self-reported use of cannabis during the third trimester was coded as yes, and any other responses were coded as no.

Data Analysis Plan

Statistical analyses were performed using SPSS version 28 (IMB Corp. Released 2021. IBM SPSS Statistics for Windows, Version 28.0. Armonk, NY: IBM Corp). Descriptive statistics were generated for sociodemographic data (age, race, ethnicity, marital status, education, gravida, and para). Researchers cleaned the data and ensured that all necessary assumptions were met for statistical analyses. Significance was set at 0.05 for all analyses.

Specific Aim 1: Describe the rates of endorsement of various adverse consequences and potential benefits of cannabis use generally, as well as during pregnancy. Frequencies of responses were generated for all individual items assessing attitudes and beliefs of cannabis use

generally, as well as for all individual items of the measure assessing attitudes and beliefs during pregnancy, across and within the three locations.

Specific aim 2: Examine the reliability and validity of the PPCU survey. The reliability of the PPCU survey was assessed by calculating Cronbach's alpha and McDonald's omega. Validity of the PPCU survey was examined by comparing responses from the PPCU survey to responses from the measure of attitudes and beliefs of general cannabis use.

Specific aim 3: Describe demographic correlates of perceptions of cannabis use during pregnancy, both within locations and overall.

The first hypothesis tested: Individuals who are younger (≤25 years) will be more likely to have higher PPCU scores than individuals who are older (>25 years). This hypothesis was tested using independent samples t-tests to compare scores on the PPCU survey among individuals who are ≤25 years of age and those who are >25 years of age.

The second hypothesis tested: Individuals who are unmarried will be more likely to have higher PPCU scores than individuals who are married/living as married. This hypothesis was tested using independent samples t-tests to compare scores on the PPCU survey among individuals who are married (or living as married) and those who are not.

The third hypothesis tested: Individuals with a lower education level (≤high school/GED) will be more likely to have higher PPCU scores than individuals with a higher education level (>high school/GED). This hypothesis was tested using independent samples t-tests to compare scores on the PPCU among individuals whose education level is ≤high school/GED and those whose education level is >high school/GED.

The fourth hypothesis tested: Individuals who self-reported recent cannabis use will be more likely to have higher PPCU scores than individuals who did not self-report recent cannabis

use. This hypothesis was tested using independent samples t-tests to compare scores on the PPCU among individuals who reported recent cannabis use and those who did not.

Specific aim 4: Explore differences in perceptions of cannabis use across three locations (Denver, Pittsburgh, Richmond), given the differing time points of data collection and status of cannabis legality at time of data collection. Scores on the PPCU survey were compared across locations (Denver, Pittsburgh, Richmond) using one-way ANOVAs. Additionally, since data at the Pittsburgh location was collected during two separate recruitment periods, scores on the PPCU survey for this location were also compared between these two time periods.

Results

Demographics

Characteristics of the three data collection sites are summarized in Table 4, including the period of data collection, status of cannabis legality at time of data collection, sample size, and rates of cannabis use among each sample. Sites varied in time of data collection by almost a decade, ranging from 2013 to 2022. Status of cannabis legality also varied between sites and across time of data collection, from being illegal both medically and recreationally, to being legal both medically and recreationally. Additionally, while the overall sample size for all three sites combined was N = 582, the sample size at each individual site ranged from N = 103 (Denver) to N = 279 (Pittsburgh).

Table 4. Data Collection Site Characteristics

Location	Time Period of Data Collection	Cannabis Legality Status	Sample Size	Cannabis Use
Denver, CO	Jan. 26, 2015-Sept. 16, 2015.	Legal medically and recreationally throughout data collection.	N=103	5% of participants reported recent cannabis use.
Pittsburgh, PA	Dec. 5, 2013-July 14, 2015.	Illegal medically and recreationally	N=215	Not collected at this site.

		throughout data collection.		
Pittsburgh, PA	July 18, 2018-Aug. 6, 2019.	Legal medically and illegal recreationally throughout data collection.	N=64	Not collected at this site.
Richmond, VA	May 5, 2021-July 8, 2022.	Legal medically throughout data collection; legal recreationally from July 1, 2021, onward.	N=200	11.2% of participants reported recent cannabis use.

Demographic characteristics of the sample are described in Table 5. For the total sample, participants (N = 582) had a mean age of 30.65 years (*SD* = 9.1). They were predominantly White (43.2%), followed closely by Black/African American (42.5%). Slightly over half (51.0%) of all participants were unmarried/not living as married, and two-thirds (66.1%) reported having completed some college or a bachelor's or advanced degree.

Sample demographics varied across the three sites. Denver and Richmond samples had many similarities: all were women of child-bearing age and were predominantly white, married/living as married, and had completed a college degree or above. Alternatively, for the Pittsburgh sample, participant age extended to 72 years, just over half (55.8%) identified as Black/African American, 61.5% were single and had never been married, and most participants had completed high school or a GED. Pregnancy status also differed across sites, from nearly all participants being pregnant (Denver) to all participants being postpartum (Richmond).

Table 5. Sample Demographics of Data Collection Locations

Location	Age	Race	Marital Status	Education	Gravida / Para	Pregnancy Status of Participants
Denver (N=103)	Range: 18-43 Mean: 29.9 ≤25: 28% >25: 72%	54% White 14% Black/African American 12% Latino/Latina 3% American Indian or Alaska Native 1% Asian American 16% Other	63% Married 15% Living with a partner 19% Single, never married 2% Divorced 1% Separated	5.1% Middle school/some high school 17.3% High school/GED 24.5% Some college, no degree 33.7% College	Gravida -Range: 0-9 -Mean: 2.41 Para -Range: 0-7 -Mean: 1.42	Almost all (96.1%) of participants were pregnant.

				19.4% Graduate degree		
Pittsburgh (N=279)	Range: 18-72 Mean: 31.8 ≤25: 34.7% >25: 65.3%	32.5% White 55.8% Black / African American 0.8% Latino / Latina 0.8% American Indian or Alaska Native 1.5% Asian American 0.4% Native Hawaiian or Other Pacific Islander 8.3% Other	18.9% Married 10.0% Living with a partner 0.4% Living with a same sex partner 61.5% Single, never married 5.6% Divorced 1.5% Separated 2.2% Widowed	0.7% Grade School 4.1% Middle school/some high school 36.8% High school/GED 25.7% Some college, no degree 21.2% College 11.5% Graduate degree	<u>Gravida</u> -Range: 0-12 -Mean: 2.84 <u>Para</u> -Range: 0-9 -Mean: 1.79	Most participants (65.6%) were not pregnant.
Richmond (N=200)	Range: 18-40 Mean: 29.3 ≤25: 25.8% >25: 74.2%	52.0% White 38.9% Black / African American 3.5% Asian 5.6% Other	60.0% Married / Living as Married (5+ yrs. together) 35.5% Single / Never Married 2.0% Divorced / Separated 2.5% Other	1.0% Grades 1 through 8 4.0% Grades 9 through 11 24.1% Grade 12 or GED 13.1% Some college 6.0% Associates degree 31.7% Bachelor's degree 2.5% Technical training 4.0% College graduate 13.6% Graduate degree (Master's or Doctorate)	Only asked in new version of survey for N=102 participants. <u>Gravida</u> -Range: 1-10 -Mean: 2.57 <u>Para</u> -Range: 1-8 -Mean: 2.04	All participants were recruited in hospital, post-delivery.

*The percentages in this table are based on the number of valid cases for each variable.

Specific Aim 1: Risks and Benefits of Cannabis Use in the General Population and During Pregnancy

Perceptions of Risks and Benefits of Cannabis Use for the General Population

Perceptions about risks and benefits of cannabis use in general are summarized in Table 6 (for the total sample) and Table 7 (broken down by site). The 15 items included four that focused on risks associated with general cannabis use and 11 that described the safety and potential

benefits of general cannabis use (two of which were only administered in Pittsburgh and Richmond). Rates of "don't know/no opinion" were generally low for the 13 items administered at all three sites, ranging from 7.1% for "Marijuana is a natural herb" (Item 2) and 8.7% for "Marijuana makes people think slower" (Item 3) to 14.0% for "Marijuana makes people feel sad or depressed" (Item 4) and 16.6% for "Marijuana helps with headaches" (Item 9).

For those who did rate their perceptions from strongly agree to strongly disagree for the 13 items administered at all three sites, endorsement rates varied widely. For the four items focused on risks of general cannabis use, rates of agreement/strong agreement ranged from 13.4% for "Marijuana makes people feel sad or depressed" (Item 4) to 49.7% for "Marijuana is addictive" (Item 8). For the nine items that described the potential benefits and safety of general cannabis use, rates of agreement/strong agreement ranged from 24.0% for "Marijuana has no negative side effects" (Item 1) to 72.7% for "Marijuana is a natural herb" (Item 2). Over half of subjects agreed/strongly agreed with several statements of the benefits and safety of cannabis use, including "Marijuana is a natural herb" (72.7%; Item 2), "Marijuana helps with stress" (68.2%; Item 5), "Marijuana is healthier than cigarettes" (56.8%; Item 6), "Marijuana takes away aches and pains" (65.2%; Item 7), "Marijuana helps with headaches" (56.5%; Item 9), "Marijuana takes pain away" (64.1%; Item 10), and "Marijuana helps with anxiety" (59.5%; Item 12).

For the two items administered only in Pittsburgh and Richmond (Items 14 and 15), both of which described the potential benefits and safety of general cannabis use, over two-thirds (67.9%) of participants agreed/strongly agreed with the statement "Marijuana should be legalized" (Item 15), and one-quarter (25.8%) agreed/strongly agreed with the statement "Marijuana is not a real drug" (Item 14).

Table 6. Perceptions Regarding General Cannabis Use for the Entire Sample

Item	Total N=582
1. Marijuana has no negative side effects (Benefit)	24.0% Agree/Strongly Agree (138) 16.3% Neither Agree nor Disagree (94) 51.9% Disagree/Strongly Disagree (299) 7.8% Don't know/No opinion (45) (N=6 missing)
2. Marijuana is a natural herb (Benefit)	72.7% Agree/Strongly Agree (419) 11.1% Neither Agree nor Disagree (64) 9.0% Disagree/Strongly Disagree (52) 7.1% Don't know/No opinion (41) (N=6 missing)
3. Marijuana makes people think slower (Risk)	47.9% Agree/Strongly Agree (276) 24.5% Neither Agree nor Disagree (141) 18.9% Disagree/Strongly Disagree (109) 8.7% Don't know/No opinion (50) (N=6 missing)
4. Marijuana makes people feel sad or depressed (Risk)	13.4% Agree/Strongly Agree (77) 26.9% Neither Agree nor Disagree (154) 45.7% Disagree/Strongly Disagree (262) 14.0% Don't know/No opinion (80) (N=9 missing)
5. Marijuana helps with stress (Benefit)	68.2% Agree/Strongly Agree (393) 14.2% Neither Agree nor Disagree (82) 7.8% Disagree/Strongly Disagree (45) 9.7% Don't know/No opinion (56) (N=6 missing)
6. Marijuana is healthier than cigarettes (Benefit)	56.8% Agree/Strongly Agree (327) 17.2% Neither Agree nor Disagree (99) 17.2% Disagree/Strongly Disagree (99) 8.9% Don't know/No opinion (51) (N=6 missing)
7. Marijuana takes away aches and pains (Benefit)	65.2% Agree/Strongly Agree (374) 13.9% Neither Agree nor Disagree (80) 8.4% Disagree/Strongly Disagree (48) 12.5% Don't know/No opinion (72) (N=8 missing)
8. Marijuana is addictive (Risk)	49.7% Agree/Strongly Agree (287) 20.1% Neither Agree nor Disagree (116) 21.1% Disagree/Strongly Disagree (122) 9.0% Don't know/No opinion (52) (N=5 missing)
9. Marijuana helps with headaches (Benefit)	56.5% Agree/Strongly Agree (327) 19.7% Neither Agree nor Disagree (114) 7.3% Disagree/Strongly Disagree (42) 16.6% Don't know/No opinion (96)

	(N=3 missing)
10. Marijuana takes pain away (Benefit)	64.1% Agree/Strongly Agree (368) 15.9% Neither Agree nor Disagree (91) 7.1% Disagree/Strongly Disagree (41) 12.9% Don't know/No opinion (74) (N=8 missing)
11. Marijuana is not a real drug because it's made of natural substances (Benefit)	28.5% Agree/Strongly Agree (165) 19.6% Neither Agree nor Disagree (113) 42.9% Disagree/Strongly Disagree (248) 9.0% Don't know/No opinion (52) (N=4 missing)
12. Marijuana helps with anxiety (Benefit)	59.5% Agree/Strongly Agree (343) 16.8% Neither Agree nor Disagree (97) 9.9% Disagree/Strongly Disagree (57) 13.7% Don't know/No opinion (79) (N=6 missing)
13. Marijuana has negative side effects (Risk)	42.4% Agree/Strongly Agree (243) 23.4% Neither Agree nor Disagree (134) 23.9% Disagree/Strongly Disagree (137) 10.3% Don't know/No opinion (59) (N=9 missing)
14. Marijuana is not a real drug (Benefit)	Only administered in PA and VA (N=479) 25.8% Agree/Strongly Agree (121) 19.4% Neither Agree nor Disagree (91) 48.4% Disagree/Strongly Disagree (227) 6.4% Don't know/No opinion (30) (N=10 missing)
15. Marijuana should be legalized (Benefit)	Only administered in PA and VA (N=479) 67.9% Agree/Strongly Agree (321) 11.8% Neither Agree nor Disagree (56) 13.7% Disagree/Strongly Disagree (65) 6.6% Don't know/No opinion (31) (N=6 missing)

Table 7. Perceptions Regarding General Cannabis Use by Recruitment Site

Item	Denver (N=103)	Pittsburgh (N=279)	Richmond (N=200)
1. Marijuana has no negative side effects (Benefit)	14.6% Agree/Strongly Agree (15) 17.5% Neither Agree nor Disagree (18) 60.2% Disagree/Strongly Disagree (62) 7.8% Don't know/No opinion (8)	32.5% Agree/Strongly Agree (90) 17.0% Neither Agree nor Disagree (47) 44.0% Disagree/Strongly Disagree (122) 6.5% Don't know/No opinion (18)	16.8% Agree/Strongly Agree (33) 14.8% Neither Agree nor Disagree (29) 58.7% Disagree/Strongly Disagree (115) 9.7% Don't know/No opinion (19)
2. Marijuana is a natural herb (Benefit)	55.3% Agree/Strongly Agree (57) 21.4% Neither Agree nor Disagree (22)	77.9% Agree/Strongly Agree (215) 6.9% Neither Agree nor Disagree (19)	74.6% Agree/Strongly Agree (147) 11.7% Neither Agree nor Disagree (23)

	11.7% Disagree/Strongly Disagree (12) 11.7% Don't know/No opinion (12)	9.4% Disagree/Strongly Disagree (26) 5.8% Don't know/No opinion (16)	7.1% Disagree/Strongly Disagree (14) 6.6% Don't know/No opinion (13)
3. Marijuana makes people think slower (Risk)	60.2% Agree/Strongly Agree (62) 19.4% Neither Agree nor Disagree (20) 8.7% Disagree/Strongly Disagree (9) 11.7% Don't know/No opinion (12)	46.0% Agree/Strongly Agree (127) 25.7% Neither Agree nor Disagree (71) 22.1% Disagree/Strongly Disagree (61) 6.2% Don't know/No opinion (17)	44.2% Agree/Strongly Agree (87) 25.4% Neither Agree nor Disagree (50) 19.8% Disagree/Strongly Disagree (39) 10.7% Don't know/No opinion (21)
4. Marijuana makes people feel sad or depressed (Risk)	10.7% Agree/Strongly Agree (11) 32.0% Neither Agree nor Disagree (33) 33.0% Disagree/Strongly Disagree (34) 24.3% Don't know/No opinion (25)	16.6% Agree/Strongly Agree (45) 22.9% Neither Agree nor Disagree (62) 50.2% Disagree/Strongly Disagree (136) 10.3% Don't know/No opinion (28)	10.6% Agree/Strongly Agree (21) 29.6% Neither Agree nor Disagree (59) 46.2% Disagree/Strongly Disagree (92) 13.6% Don't know/No opinion (27)
5. Marijuana helps with stress (Benefit)	54.4% Agree/Strongly Agree (56) 21.4% Neither Agree nor Disagree (22) 7.8% Disagree/Strongly Disagree (8) 16.5% Don't know/No opinion (17)	75.2% Agree/Strongly Agree (206) 9.1% Neither Agree nor Disagree (25) 8.4% Disagree/Strongly Disagree (23) 7.3% Don't know/No opinion (20)	65.8% Agree/Strongly Agree (131) 17.6% Neither Agree nor Disagree (35) 7.0% Disagree/Strongly Disagree (14) 9.5% Don't know/No opinion (19)
6. Marijuana is healthier than cigarettes (Benefit)	41.2% Agree/Strongly Agree (42) 19.6% Neither Agree nor Disagree (20) 30.4% Disagree/Strongly Disagree (31) 8.8% Don't know/No opinion (9)	63.3% Agree/Strongly Agree (174) 13.5% Neither Agree nor Disagree (37) 16.0% Disagree/Strongly Disagree (44) 7.3% Don't know/No opinion (20)	55.8% Agree/Strongly Agree (111) 21.1% Neither Agree nor Disagree (42) 12.1% Disagree/Strongly Disagree (24) 11.1% Don't know/No opinion (22)
7. Marijuana takes away aches and pains (Benefit)	57.4% Agree/Strongly Agree (58) 14.9% Neither Agree nor Disagree (15) 5.0% Disagree/Strongly Disagree (5) 22.8% Don't know/No opinion (23)	67.9% Agree/Strongly Agree (186) 12.0% Neither Agree nor Disagree (33) 11.3% Disagree/Strongly Disagree (31) 8.8% Don't know/No opinion (24)	65.3% Agree/Strongly Agree (130) 16.1% Neither Agree nor Disagree (32) 6.0% Disagree/Strongly Disagree (12) 12.6% Don't know/No opinion (25)
8. Marijuana is addictive (Risk)	47.6% Agree/Strongly Agree (49) 21.4% Neither Agree nor Disagree (22) 14.6% Disagree/Strongly Disagree (15)	52.0% Agree/Strongly Agree (143) 16.7% Neither Agree nor Disagree (46) 26.5% Disagree/Strongly Disagree (73)	47.7% Agree/Strongly Agree (95) 24.1% Neither Agree nor Disagree (48) 17.1% Disagree/Strongly Disagree (34)

	16.5% Don't know/No opinion (17)	4.7% Don't know/No opinion (13)	11.1% Don't know/No opinion (22)
9. Marijuana helps with headaches (Benefit)	47.6% Agree/Strongly Agree (49) 20.4% Neither Agree nor Disagree (21) 4.9% Disagree/Strongly Disagree (5) 27.2% Don't know/No opinion (28)	60.3% Agree/Strongly Agree (167) 18.4% Neither Agree nor Disagree (51) 9.0% Disagree/Strongly Disagree (25) 12.3% Don't know/No opinion (34)	55.8% Agree/Strongly Agree (111) 21.1% Neither Agree nor Disagree (42) 6.0% Disagree/Strongly Disagree (12) 17.1% Don't know/No opinion (34)
10. Marijuana takes pain away (Benefit)	56.3% Agree/Strongly Agree (58) 15.5% Neither Agree nor Disagree (16) 5.8% Disagree/Strongly Disagree (6) 22.3% Don't know/No opinion (23)	66.2% Agree/Strongly Agree (180) 15.8% Neither Agree nor Disagree (43) 8.5% Disagree/Strongly Disagree (23) 9.6% Don't know/No opinion (26)	65.3% Agree/Strongly Agree (130) 16.1% Neither Agree nor Disagree (32) 6.0% Disagree/Strongly Disagree (12) 12.6% Don't know/No opinion (25)
11. Marijuana is not a real drug because it's made of natural substances (Benefit)	10.8% Agree/Strongly Agree (11) 19.6% Neither Agree nor Disagree (20) 56.9% Disagree/Strongly Disagree (58) 12.7% Don't know/No opinion (13)	39.4% Agree/Strongly Agree (109) 20.2% Neither Agree nor Disagree (56) 34.3% Disagree/Strongly Disagree (95) 6.1% Don't know/No opinion (17)	22.6% Agree/Strongly Agree (45) 18.6% Neither Agree nor Disagree (37) 47.7% Disagree/Strongly Disagree (95) 11.1% Don't know/No opinion (22)
12. Marijuana helps with anxiety (Benefit)	39.8% Agree/Strongly Agree (41) 24.3% Neither Agree nor Disagree (25) 9.7% Disagree/Strongly Disagree (10) 26.2% Don't know/No opinion (27)	64.6% Agree/Strongly Agree (177) 13.9% Neither Agree nor Disagree (38) 11.7% Disagree/Strongly Disagree (32) 9.9% Don't know/No opinion (27)	62.8% Agree/Strongly Agree (125) 17.1% Neither Agree nor Disagree (34) 7.5% Disagree/Strongly Disagree (15) 12.6% Don't know/No opinion (25)
13. Marijuana has negative side effects (Risk)	53.9% Agree/Strongly Agree (55) 20.6% Neither Agree nor Disagree (21) 11.8% Disagree/Strongly Disagree (12) 13.7% Don't know/No opinion (14)	37.4% Agree/Strongly Agree (102) 22.3% Neither Agree nor Disagree (61) 31.5% Disagree/Strongly Disagree (86) 8.8% Don't know/No opinion (24)	43.4% Agree/Strongly Agree (86) 26.3% Neither Agree nor Disagree (52) 19.7% Disagree/Strongly Disagree (39) 10.6% Don't know/No opinion (21)
14. Marijuana is not a real drug (Benefit)	Not included in survey at this recruitment site.	30.7% Agree/Strongly Agree (83) 17.8% Neither Agree nor Disagree (48) 46.3% Disagree/Strongly Disagree (125)	19.1% Agree/Strongly Agree (38) 21.6% Neither Agree nor Disagree (43) 51.3% Disagree/Strongly Disagree (102)

		5.2% Don't know/No opinion (14)	8.0% Don't know/No opinion (16)
15. Marijuana should be legalized (Benefit)	Not included in survey at this recruitment site.	71.9% Agree/Strongly Agree (197) 9.9% Neither Agree nor Disagree (27) 12.8% Disagree/Strongly Disagree (35) 5.5% Don't know/No opinion (15)	62.3% Agree/Strongly Agree (124) 14.6% Neither Agree nor Disagree (29) 15.1% Disagree/Strongly Disagree (30) 8.0% Don't know/No opinion (16)

Perceptions of Risks and Benefits of Cannabis Use During Pregnancy

Perceptions about risks and benefits of prenatal cannabis use for the Likert-scale items in the PPCU are summarized in Table 8 (for the total sample) and Table 9 (broken down by site). The 16 items in the PPCU included eight that focused on risks associated with prenatal cannabis use and eight that described the safety and potential benefits of prenatal cannabis use. Highest rates of "don't know/no opinion" for the PPCU items were for "Marijuana use during pregnancy can lead to a larger baby" (42.8%; Item 7) and "Marijuana use during pregnancy can lower mom's blood pressure which is good for the baby" (39.3%; Item 6). Lowest rates of "don't know/no opinion" were for "Marijuana use during pregnancy can expose the baby to chemicals" (23.9%; Item 8) and "Marijuana is ok to use during pregnancy" (20.4%; Item 16).

For those who did rate their perceptions from strongly agree to strongly disagree for the PPCU items, endorsement rates varied. For the eight items focused on risks of prenatal cannabis use, rates of agreement/strong agreement ranged from 17.2% for "Marijuana use during pregnancy can make the baby addicted to it in the future" (Item 10) to 57.4% for "Marijuana can reach the baby through the placenta if used during pregnancy" (Item 2). Over half of subjects agreed/strongly agreed with two statements describing risks of prenatal cannabis use: "Marijuana use during pregnancy can affect the baby's development" (50.1%; Item 4) and "Marijuana can reach the baby through the placenta if used during pregnancy" (57.4%; Item 2). Further, nearly

half of participants agreed/strongly agreed with an additional two statements describing risks of prenatal cannabis use: “Marijuana use during pregnancy can affect the brain of the baby” (48.4%; Item 3) and “Marijuana use during pregnancy can expose the baby to chemicals” (49.8%; Item 8). One-third of participants agreed/strongly agreed with the statement “Marijuana use during pregnancy can give the baby breathing problems in the future” (33.7%; Item 9), and slightly under one-third agreed/strongly agreed with the statements, “Marijuana use during pregnancy can leader to a smaller baby” (29.6%; Item 1) and “Marijuana use during pregnancy can block nutrients from reaching the baby” (29.8%; Item 5).

For the eight items that described the potential safety and benefits of prenatal cannabis use, rates of agreement/strong agreement ranged from 8.4% for “Marijuana use during pregnancy can lead to a larger baby” (Item 7) to 46.1% for “Marijuana increases the mother’s appetite during pregnancy” (Item 14). Slightly over one-third of women agreed/strongly agreed with the statements “Marijuana helps with morning sickness and nausea during pregnancy” (38.7%; Item 13) and “Marijuana helps keep food down during pregnancy” (34.3%; Item 15), and slightly under one-third agreed/strongly agreed with “Marijuana helps alleviate or block common feelings of depression during pregnancy” (31.1%; Item 12). Additionally, about one-quarter of subjects agreed/strongly agreed with the statement “Marijuana has not been proven to be dangerous during pregnancy for either mother or child” (26.6%; Item 11).

Table 8. Perceptions Regarding Prenatal Cannabis Use for PPCU Items Combined Across Sites

Variable	Total N=582
1. Marijuana use during pregnancy can lead to a smaller baby (Risk)	29.6% Agree/Strongly Agree (169) 19.6% Neither Agree nor Disagree (112) 15.6% Disagree/Strongly Disagree (89) 35.1% Don’t know/No opinion (200) (N=12 missing)
2. Marijuana can reach the baby through the placenta if used during pregnancy (Risk)	57.4% Agree/Strongly Agree (328) 10.9% Neither Agree nor Disagree (62) 4.0% Disagree/Strongly Disagree (23)

	27.7% Don't know/No opinion (158) (N=11 missing)
3. Marijuana during pregnancy can affect the brain of the baby (Risk)	48.4% Agree/Strongly Agree (278) 14.1% Neither Agree nor Disagree (81) 9.8% Disagree/Strongly Disagree (56) 27.7% Don't know/No opinion (159) (N=8 missing)
4. Marijuana use during pregnancy can affect the baby's development (Risk)	50.1% Agree/Strongly Agree (287) 13.4% Neither Agree nor Disagree (77) 11.3% Disagree/Strongly Disagree (65) 25.1% Don't know/No opinion (144) (N=9 missing)
5. Marijuana use during pregnancy can block nutrients from reaching the baby (Risk)	29.8% Agree/Strongly Agree (171) 15.5% Neither Agree nor Disagree (89) 19.0% Disagree/Strongly Disagree (109) 35.7% Don't know/No opinion (205) (N=8 missing)
6. Marijuana use during pregnancy can lower mom's blood pressure which is good for the baby (Benefit)	20.0% Agree/Strongly Agree (114) 19.3% Neither Agree nor Disagree (110) 21.4% Disagree/Strongly Disagree (122) 39.3% Don't know/No opinion (224) (N=12 missing)
7. Marijuana use during pregnancy can lead to a larger baby (Benefit)	8.4% Agree/Strongly Agree (48) 23.9% Neither Agree nor Disagree (137) 25.0% Disagree/Strongly Disagree (143) 42.8% Don't know/No opinion (245) (N=9 missing)
8. Marijuana use during pregnancy can expose the baby to chemicals (Risk)	49.8% Agree/Strongly Agree (286) 14.5% Neither Agree nor Disagree (83) 11.8% Disagree/Strongly Disagree (68) 23.9% Don't know/No opinion (137) (N=8 missing)
9. Marijuana use during pregnancy can give the baby breathing problems in the future (Risk)	33.7% Agree/Strongly Agree (193) 16.2% Neither Agree nor Disagree (93) 14.0% Disagree/Strongly Disagree (80) 36.1% Don't know/No opinion (207) (N=9 missing)
10. Marijuana use during pregnancy can make the baby addicted to it in the future (Risk)	17.2% Agree/Strongly Agree (99) 19.8% Neither Agree nor Disagree (114) 32.2% Disagree/Strongly Disagree (185) 30.8% Don't know/No opinion (177) (N=7 missing)
11. Marijuana has not been proven to be dangerous during pregnancy for either mother or child (Benefit)	26.6% Agree/Strongly Agree (152) 19.9% Neither Agree nor Disagree (114) 19.8% Disagree/Strongly Disagree (113)

	33.7% Don't know/No opinion (193) (N=10 missing)
12. Marijuana helps alleviate or block common feelings of depression during pregnancy (Benefit)	31.1% Agree/Strongly Agree (178) 19.4% Neither Agree nor Disagree (111) 15.9% Disagree/Strongly Disagree (91) 33.6% Don't know/No opinion (192) (N=10 missing)
13. Marijuana helps with morning sickness and nausea during pregnancy (Benefit)	38.7% Agree/Strongly Agree (222) 14.5% Neither Agree nor Disagree (83) 12.7% Disagree/Strongly Disagree (73) 34.0% Don't know/No opinion (195) (N=9 missing)
14. Marijuana increases the mother's appetite during pregnancy (Benefit)	46.1% Agree/Strongly Agree (264) 13.8% Neither Agree nor Disagree (79) 8.7% Disagree/Strongly Disagree (50) 31.4% Don't know/No opinion (180) (N=9 missing)
15. Marijuana helps keep food down during pregnancy (Benefit)	34.3% Agree/Strongly Agree (197) 19.5% Neither Agree nor Disagree (112) 9.2% Disagree/Strongly Disagree (53) 37.0% Don't know/No opinion (213) (N=7 missing)
16. Marijuana is ok to use during pregnancy (Benefit)	17.5% Agree/Strongly Agree (100) 19.4% Neither Agree nor Disagree (111) 42.8% Disagree/Strongly Disagree (245) 20.4% Don't know/No opinion (117) (N=9 missing)

Table 9. Perceptions Regarding Prenatal Cannabis Use for PPCU Items by Recruitment Site

Variable	Denver (N=103)	Pittsburgh (N=279)	Richmond (N=200)
1. Marijuana use during pregnancy can lead to a smaller baby (Risk)	15.8% Agree/Strongly Agree (16) 15.8% Neither Agree nor Disagree (16) 9.9% Disagree/Strongly Disagree (10) 58.4% Don't know/No opinion (59)	35.1% Agree/Strongly Agree (95) 19.6% Neither Agree nor Disagree (53) 21.4% Disagree/Strongly Disagree (58) 24.0% Don't know/No opinion (65)	29.3% Agree/Strongly Agree (58) 21.7% Neither Agree nor Disagree (43) 10.6% Disagree/Strongly Disagree (21) 38.4% Don't know/No opinion (76)
2. Marijuana can reach the baby through the placenta if used during pregnancy (Risk)	49.0% Agree/Strongly Agree (49) 7.0% Neither Agree nor Disagree (7) 2.0% Disagree/Strongly Disagree (2) 42.0% Don't know/No opinion (42)	59.9% Agree/Strongly Agree (164) 13.5% Neither Agree nor Disagree (37) 4.4% Disagree/Strongly Disagree (12) 22.3% Don't know/No opinion (61)	58.4% Agree/Strongly Agree (115) 9.1% Neither Agree nor Disagree (18) 4.6% Disagree/Strongly Disagree (9) 27.9% Don't know/No opinion (55)

3. Marijuana use during pregnancy can affect the brain of the baby (Risk)	38.6% Agree/Strongly Agree (39) 7.9% Neither Agree nor Disagree (8) 3.0% Disagree/Strongly Disagree (3) 50.5% Don't know/No opinion (51)	49.8% Agree/Strongly Agree (137) 16.7% Neither Agree nor Disagree (46) 12.0% Disagree/Strongly Disagree (33) 21.5% Don't know/No opinion (59)	51.5% Agree/Strongly Agree (102) 13.6% Neither Agree nor Disagree (27) 10.1% Disagree/Strongly Disagree (20) 24.7% Don't know/No opinion (49)
4. Marijuana use during pregnancy can affect the baby's development (Risk)	39.6% Agree/Strongly Agree (40) 6.9% Neither Agree nor Disagree (7) 6.9% Disagree/Strongly Disagree (7) 46.5% Don't know/No opinion (47)	49.5% Agree/Strongly Agree (136) 14.9% Neither Agree nor Disagree (41) 14.9% Disagree/Strongly Disagree (41) 20.7% Don't know/No opinion (57)	56.3% Agree/Strongly Agree (111) 14.7% Neither Agree nor Disagree (29) 8.6% Disagree/Strongly Disagree (17) 20.3% Don't know/No opinion (40)
5. Marijuana use during pregnancy can block nutrients from reaching the baby (Risk)	18.8% Agree/Strongly Agree (19) 8.9% Neither Agree nor Disagree (9) 7.9% Disagree/Strongly Disagree (8) 64.4% Don't know/No opinion (65)	34.1% Agree/Strongly Agree (94) 17.8% Neither Agree not Disagree (48) 22.8% Disagree/Strongly Disagree (63) 25.4% Don't know/No opinion (70)	29.4% Agree/Strongly Agree (58) 15.7% Neither Agree nor Disagree (31) 19.3% Disagree/Strongly Disagree (38) 35.5% Don't know/No opinion (70)
6. Marijuana use during pregnancy can lower mom's blood pressure which is good for the baby (Benefit)	6.0% Agree/Strongly Agree (6) 12.0% Neither Agree nor Disagree (12) 17.0% Disagree/Strongly Disagree (17) 65.0% Don't know/No opinion (65)	23.8% Agree/Strongly Agree (65) 20.9% Neither Agree nor Disagree (57) 23.4% Disagree/Strongly Disagree (64) 31.9% Don't know/No opinion (87)	21.8% Agree/Strongly Agree (43) 20.8% Neither Agree nor Disagree (41) 20.8% Disagree/Strongly Disagree (41) 36.5% Don't know/No opinion (72)
7. Marijuana use during pregnancy can lead to a larger baby (Benefit)	3.0% Agree/Strongly Agree (3) 14.9% Neither Agree nor Disagree (15) 13.9% Disagree/Strongly Disagree (14) 68.3% Don't know/No opinion (69)	11.7% Agree/Strongly Agree (32) 27.7% Neither Agree nor Disagree (76) 27.0% Disagree/Strongly Disagree (74) 33.6% Don't know/No opinion (92)	6.6% Agree/Strongly Agree (13) 23.2% Neither Agree nor Disagree (46) 27.8% Disagree/Strongly Disagree (55) 42.4% Don't know/No opinion (84)
8. Marijuana use during pregnancy can expose the baby to chemicals (Risk)	45.0% Agree/Strongly Agree (45) 6.0% Neither Agree nor Disagree (6) 10.0% Disagree/Strongly Disagree (10) 39.0% Don't know/No opinion (39)	48.6% Agree/Strongly Agree (134) 17.0% Neither Agree nor Disagree (47) 13.4% Disagree/Strongly Disagree (37) 21.0% Don't know/No opinion (58)	54.0% Agree/Strongly Agree (107) 15.2% Neither Agree nor Disagree (30) 10.6% Disagree/Strongly Disagree (21) 20.2% Don't know/No opinion (40)

9. Marijuana use during pregnancy can give the baby breathing problems in the future (Risk)	18.8% Agree/Strongly Agree (19) 8.9% Neither Agree nor Disagree (9) 9.9% Disagree/Strongly Disagree (10) 62.4% Don't know/No opinion (63)	39.3% Agree/Strongly Agree (108) 17.8% Neither Agree nor Disagree (49) 13.8% Disagree/Strongly Disagree (38) 29.1% Don't know/No opinion (80)	33.5% Agree/Strongly Agree (66) 17.8% Neither Agree nor Disagree (35) 16.2% Disagree/Strongly Disagree (32) 32.5% Don't know/No opinion (64)
10. Marijuana use during pregnancy can make the baby addicted to it in the future (Risk)	17.0% Agree/Strongly Agree (17) 11.0% Neither Agree nor Disagree (11) 18.0% Disagree/Strongly Disagree (18) 54.0% Don't know/No opinion (54)	18.1% Agree/Strongly Agree (50) 22.4% Neither Agree nor Disagree (62) 35.0% Disagree/Strongly Disagree (97) 24.5% Don't know/No opinion (68)	16.2% Agree/Strongly Agree (32) 20.7% Neither Agree nor Disagree (41) 35.4% Disagree/Strongly Disagree (70) 27.8% Don't know/No opinion (55)
11. Marijuana has not been proven to be dangerous during pregnancy for either mother or child (Benefit)	17.2% Agree/Strongly Agree (17) 9.1% Neither Agree nor Disagree (9) 17.2% Disagree/Strongly Disagree (17) 56.6% Don't know/No opinion (56)	29.1% Agree/Strongly Agree (80) 22.9% Neither Agree nor Disagree (63) 19.6% Disagree/Strongly Disagree (54) 28.4% Don't know/No opinion (78)	27.8% Agree/Strongly Agree (55) 21.2% Neither Agree nor Disagree (42) 21.2% Disagree/Strongly Disagree (42) 29.8% Don't know/No opinion (59)
12. Marijuana helps alleviate or block common feelings of depression during pregnancy (Benefit)	9.9% Agree/Strongly Agree (10) 13.9% Neither Agree nor Disagree (14) 16.8% Disagree/Strongly Disagree (17) 59.4% Don't know/No opinion (60)	33.7% Agree/Strongly Agree (92) 20.5% Neither Agree nor Disagree (56) 18.7% Disagree/Strongly Disagree (51) 27.1% Don't know/No opinion (74)	38.4% Agree/Strongly Agree (76) 20.7% Neither Agree nor Disagree (41) 11.6% Disagree/Strongly Disagree (23) 29.3% Don't know/No opinion (58)
13. Marijuana helps with morning sickness and nausea during pregnancy (Benefit)	13.0% Agree/Strongly Agree (13) 8.0% Neither Agree nor Disagree (8) 19.0% Disagree/Strongly Disagree (19) 60.0% Don't know/No opinion (60)	46.5% Agree/Strongly Agree (128) 15.6% Neither Agree nor Disagree (43) 13.1% Disagree/Strongly Disagree (36) 24.7% Don't know/No opinion (68)	40.9% Agree/Strongly Agree (81) 16.2% Neither Agree nor Disagree (32) 9.1% Disagree/Strongly Disagree (18) 33.8% Don't know/No opinion (67)
14. Marijuana increases the mother's appetite during pregnancy	15.8% Agree/Strongly Agree (16) 6.9% Neither Agree nor Disagree (7) 16.8% Disagree/Strongly Disagree (17)	58.8% Agree/Strongly Agree (161) 13.5% Neither Agree nor Disagree (37) 7.3% Disagree/Strongly Disagree (20)	43.9% Agree/Strongly Agree (87) 17.7% Neither Agree nor Disagree (35) 6.6% Disagree/Strongly Disagree (13)

(Benefit)	60.4% Don't know/No opinion (61)	20.4% Don't know/No opinion (56)	31.8% Don't know/No opinion (63)
15. Marijuana helps keep food down during pregnancy (Benefit)	10.9% Agree/Strongly Agree (11) 10.9% Neither Agree nor Disagree (11) 13.9% Disagree/Strongly Disagree (14) 64.4% Don't know/No opinion (65)	44.2% Agree/Strongly Agree (122) 18.5% Neither Agree nor Disagree (51) 8.3% Disagree/Strongly Disagree (23) 29.0% Don't know/No opinion (80)	32.3% Agree/Strongly Agree (64) 25.3% Neither Agree nor Disagree (50) 8.1% Disagree/Strongly Disagree (16) 34.3% Don't know/No opinion (68)
16. Marijuana is ok to use during pregnancy (Benefit)	7.9% Agree/Strongly Agree (8) 10.9% Neither Agree nor Disagree (11) 54.5% Disagree/Strongly Disagree (55) 26.7% Don't know/No opinion (27)	22.6% Agree/Strongly Agree (62) 19.7% Neither Agree nor Disagree (54) 38.3% Disagree/Strongly Disagree (105) 19.3% Don't know/No opinion (53)	15.2% Agree/Strongly Agree (30) 23.2% Neither Agree nor Disagree (46) 42.9% Disagree/Strongly Disagree (85) 18.7% Don't know/No opinion (37)

Perceptions about prenatal cannabis use for the site-specific items that were not included in the PPCU are summarized in Table 10 (for the total sample). These 13 items included six that focused on risks associated with prenatal cannabis use and seven that described the safety and potential benefits of prenatal cannabis use. Rates of "don't know/no opinion" ranged from 17.7% for "Marijuana is not safe to use during pregnancy" (Item 1) to 59.6% for "Marijuana helps reduce stress in pregnancy" (Item 5).

Rates of endorsement varied for those who did rate their perceptions from strongly agree to strongly disagree. For the six items focused on risks of prenatal cannabis use, rates of agreement/strong agreement ranged from 17.6% for "Marijuana use during pregnancy (or postpartum) can affect the mother's ability to attach or bond with her baby" (Item 2) to 57.4% for "Marijuana in any form is not safe to use during pregnancy" (Item 13). Over half of participants agreed/strongly agreed with two statements focused on risks of prenatal cannabis use, including "Marijuana in any form is not safe to use during pregnancy" (57.4%; Item 13) and "Marijuana can cross into a mother's breast milk" (53.5%; Item 6), and almost half agreed/strongly agreed with the statements "Marijuana is not safe to use during pregnancy" (44.8%; Item 1) and

"Marijuana can affect a baby if it is in the breast milk" (45.3% Item 4). For the seven items that described the potential benefits and safety of prenatal cannabis use, rates of agreement/strong agreement ranged from 4.0% for "Vaporized marijuana is safer than smoking marijuana during pregnancy" (Item 11) to 17.8% for "Smoking marijuana is safer than smoking cigarettes during pregnancy" (Item 8).

Table 10. Perceptions Regarding Prenatal Cannabis Use for Items Not in the PPCU Combined Across Sites

Variable	Total N=582
1. Marijuana is not safe to use during pregnancy (Risk)	Only administered in PA and VA (N=479) 44.8% Agree/Strongly Agree (210) 21.5% Neither Agree nor Disagree (101) 16.0% Disagree/Strongly Disagree (75) 17.7% Don't know/No opinion (83) (N=10 missing)
2. Marijuana use during pregnancy (or postpartum) can affect the mother's ability to attach or bond with her baby (Risk)	Only administered in new survey version in VA (N=102) 17.6% Agree/Strongly Agree (18) 20.6% Neither Agree nor Disagree (21) 30.4% Disagree/Strongly Disagree (31) 31.4% Don't know/No opinion (32)
3. The legalization of marijuana will increase use among pregnant women (Risk)	Only administered in new survey version in VA (N=102) 38.6% Agree/Strongly Agree (39) 22.8% Neither Agree nor Disagree (23) 19.8% Disagree/Strongly Disagree (20) 18.8% Don't know/No opinion (19) (N=1 missing)
4. Marijuana can affect a baby if it is in the breast milk (Risk)	Only administered in CO and new survey version in VA (N=205) 45.3% Agree/Strongly Agree (91) 10.0% Neither Agree nor Disagree (20) 6.5% Disagree/Strongly Disagree (13) 38.3% Don't know/No opinion (77) (N=4 missing)
5. Marijuana helps reduce stress in pregnancy (Benefit)	Only administered in CO (N=103) 15.2% Agree/Strongly Agree (15) 10.1% Neither Agree nor Disagree (10) 15.2% Disagree/Strongly Disagree (15) 59.6% Don't know/No opinion (59) (N=4 missing)
6. Marijuana can cross into a mother's breast milk (Risk)	Only administered in CO (N=103) 53.5% Agree/Strongly Agree (54) 5.9% Neither Agree nor Disagree (6)

	1.0% Disagree/Strongly Disagree (1) 39.6% Don't know/No opinion (40) (N=2 missing)
7. Using marijuana is safer than drinking alcohol during pregnancy (Benefit)	Only administered in CO (N=103) 15.8% Agree/Strongly Agree (16) 13.9% Neither Agree nor Disagree (14) 37.6% Disagree/Strongly Disagree (38) 32.7% Don't know/No opinion (33) (N=2 missing)
8. Smoking marijuana is safer than smoking cigarettes during pregnancy (Benefit)	Only administered in CO (N=103) 17.8% Agree/Strongly Agree (18) 13.9% Neither Agree nor Disagree (14) 37.6% Disagree/Strongly Disagree (38) 30.7% Don't know/No opinion (31) (N=2 missing)
9. Edibles are safer than smoking marijuana during pregnancy (Benefit)	Only administered in CO (N=103) 10.0% Agree/Strongly Agree (10) 10.0% Neither Agree nor Disagree (10) 41.0% Disagree/Strongly Disagree (41) 39.0% Don't know/No opinion (39) (N=3 missing)
10. Marijuana in pill form is safer than smoking marijuana during pregnancy (Benefit)	Only administered in CO (N=103) 5.9% Agree/Strongly Agree (6) 12.9% Neither Agree nor Disagree (13) 39.6% Disagree/Strongly Disagree (40) 41.6% Don't know/No opinion (42) (N=2 missing)
11. Vaporized marijuana is safer than smoking marijuana during pregnancy (Benefit)	Only administered in CO (N=103) 4.0% Agree/Strongly Agree (4) 13.9% Neither Agree nor Disagree (14) 38.6% Disagree/Strongly Disagree (39) 43.6% Don't know/No opinion (44) (N=2 missing)
12. Using marijuana through the skin (like oils or patch) is safer than smoking marijuana during pregnancy (Benefit)	Only administered in CO (N=103) 8.0% Agree/Strongly Agree (8) 14.0% Neither Agree nor Disagree (14) 35.0% Disagree/Strongly Disagree (35) 43.0% Don't know/No opinion (43) (N=3 missing)
13. Marijuana in any form is not safe to use during pregnancy (Risk)	Only administered in CO (N=103) 57.4% Agree/Strongly Agree (58) 14.9% Neither Agree nor Disagree (15) 5.9% Disagree/Strongly Disagree (6) 21.8% Don't know/No opinion (22) (N=2 missing)

Specific Aim 2: Reliability and validity of the PPCU

The PPCU is a measure of attitudes and beliefs of prenatal cannabis use that was designed by Dr. Jeanelle Sheeder and colleagues based on their clinical experience and knowledge. It contains 16 items assessing perceptions of risks (N = 8) and benefits (N = 8) of prenatal cannabis use. Items include broad statements about the safety of cannabis use during pregnancy, as well as more specific items about whether prenatal cannabis use could lead to in utero chemical exposure. Reliability of the PPCU was first assessed by calculating Cronbach's alpha. All cases with missing data were deleted listwise, resulting in N = 210 valid cases. Cronbach's alpha demonstrated that the PPCU had good reliability ($\alpha = .894$). Additionally, reliability was also assessed by calculating McDonald's omega, as this has been shown to be a robust alternative to Cronbach's alpha. McDonald's omega was initially unable to be estimated using all 16 items in the PPCU due to negative item covariances. Upon assessing the inter-item covariances for the 16 items, Item 6 was removed due to its negative covariance with most of the other PPCU items. McDonald's omega was then calculated for the remaining 15 items of the PPCU. All cases with missing data were deleted listwise, resulting in N = 214 valid cases. The resulting value for McDonald's omega also demonstrated good reliability ($\omega = .904$).

Validity of the PPCU was examined by comparing responses from the PPCU to similar responses from the measure of attitudes and beliefs of general cannabis use. Responses to an item assessing the perception of whether cannabis is generally okay to use ("Marijuana has no negative side effects") were compared to responses on a similar item on the PPCU (Item 16), and there was a significant positive correlation between the two items, $r = .26$, $p < .001$. There were no other items from the PPCU that closely mapped onto items from the measure of attitudes and beliefs of general cannabis use, so correlations were not assessed for any other items.

For each individual item of the PPCU, participants were provided with response options on a five-point Likert scale from 1 = "strongly disagree" to 5 = "strongly agree," as well as a "don't know/no opinion" option. Items assessing the risks of prenatal cannabis use were reverse coded. In addition to individual item scores, a total score was calculated by summing Likert scores for the 16 items (range 1-80). Then, this total score was divided by the number of answered questions to obtain the final PPCU score, with higher PPCU scores favoring the safety/benefits of prenatal cannabis use. Responses of "don't know/no opinion" were analyzed separately.

Specific Aim 3: Demographic correlates of perceptions of cannabis use during pregnancy

Based on the literature, four hypotheses were evaluated that focused on the demographic correlates of perceptions of prenatal cannabis use. Hypotheses were tested by comparing mean PPCU scores by various demographic variables.

Hypothesis 1

Results for the testing of hypothesis 1, that younger (≤25 years) participants will have higher mean PPCU scores than older (>25 years) participants, are shown in Table 11. Across all three recruitment sites combined, when age was dichotomized, younger women (≤25 years*;* M = 2.88, SD = .90) had significantly higher mean PPCU scores than older women (>25 years; M = 2.70, SD = .86), $t(515) = 2.17$, $p < .05$, indicating that younger women were more likely than older women to view prenatal cannabis use as safer/more beneficial. Similarly, when age was run as a continuous variable for the overall sample, there was a significant negative correlation between PPCU score and age, $r = -.16$, $p < .01$, also affirming hypothesis 1.

Hypothesis 1 was also tested within each individual recruitment site. When age was dichotomized, Denver was the only site that demonstrated a significant difference between

younger women (≤25 years*; M* = 2.81, *SD* = 1.06) and older women (>25 years; *M* = 2.16, *SD* = .83) in their mean PPCU scores, *t*(86) = 3.10, *p* < .01, such that younger women were more likely to view prenatal cannabis use as safer/more beneficial. When age was run as a continuous variable by site, there was a significant negative correlation between age and PPCU score in Denver, *r* = -.29, *p* < .01, and Pittsburgh, *r* = -.19, *p* < .01, but there was no significant correlation between age and PPCU score in Richmond, *r* = -.11, *p* > .05.

Table 11. PPCU Score by Age

	N	Mean	SD	Df	t-value	p-value
All Sites Combined						
≤25 years	168	2.88	.90	515	2.17	.030*
>25 years	382	2.70	.86			
Denver (Range: 18-43)						
≤25 years	25	2.81	1.06	86	3.10	.003*
>25 years	63	2.16	.83			
Pittsburgh (Range: 18-72)						
≤25 years	88	2.92	.89	255	.28	.779
>25 years	169	2.89	.88			
Richmond (Range: 18-40)						
≤25 years	46	2.85	.83	170	.92	.357
>25 years	126	2.72	.75			

Hypothesis 2

Outcomes for hypothesis 2, which stated that individuals who were unmarried would have higher mean PPCU scores than individuals who are married/living as married, are summarized in Table 12. Across all three recruitment sites combined, the mean PPCU score for unmarried women (*M* = 2.94, *SD* = .83) was significantly higher than the mean score for women who were married/living as married (*M* = 2.56, *SD* = .89), *t*(527) = -5.05, *p* < .001, indicating that unmarried women were more likely to view prenatal cannabis use as safer/more beneficial than women who were married/living as married.

Hypothesis 2 was also tested within each individual recruitment site, and the same pattern was found for Denver and Richmond. In Denver, unmarried women (*M* = 2.93, *SD* = 1.05) had

significantly higher mean PPCU scores than women who were married/living as married (M = 2.20, SD = .86), $t(86) = -2.97$, $p < .01$, and in Richmond, unmarried women (M = 3.04, SD = .73) also had higher mean PPCU scores than women who were married/living as married (M = 2.58, SD = .77), $t(181) = -3.98$, $p < .001$. Alternatively, In Pittsburgh, there was no significant difference between women who were married/living as married (M = 2.86, SD = .96) and unmarried (M = 2.90, SD = .85) in mean PPCU scores $t(256) = -.36$, $p > .05$.

Table 12. PPCU Score by Marital Status

	N	Mean	SD	Df	t-value	p-value
All Sites Combined						
Married	262	2.56	.89	527	-5.05	<.001*
Unmarried	267	2.94	.83			
Denver						
Married	71	2.20	.86	86	-2.97	.004*
Unmarried	17	2.93	1.05			
Pittsburgh						
Married	78	2.86	.96	256	-.36	.718
Unmarried	180	2.90	.85			
Richmond						
Married	113	2.58	.77	181	-3.98	<.001*
Unmarried	70	3.04	.73			

Hypothesis 3

Results when testing the third hypothesis, that individuals with a lower education level (≤high school/GED) would have higher mean PPCU scores than individuals with a higher education level (>high school/GED), are summarized in Table 13. Across all three recruitment sites combined, women with a lower education level (≤high school/GED; M = 2.94, SD = .89) had significantly higher mean PPCU scores than women with a higher education level (>high school/GED; M = 2.66, SD = .86), $t(529) = 3.52$, $p < .001$, indicating that women with a lower education level were more likely to view prenatal cannabis use as safer/more beneficial.

Hypothesis 3 was also tested within each individual recruitment site. Denver was the only site where women with a lower education level (M = 2.96, SD = 1.12) had significantly higher

mean PPCU scores than women with a higher education level (M = 2.16, SD = .83), $t(84) = 3.37$, $p = .001$. No significant difference in PPCU scores by education level was found in Pittsburgh, $t(256) = .93$, $p > .05$, or in Richmond, $t(185) = 1.62$, $p > .05$.

Table 13. PPCU Score by Education Level

	N	Mean	SD	Df	t-value	p-value
All Sites Combined						
≤high school/GED	181	2.94	.89	529	3.52	<.001*
>high school/GED	350	2.66	.86			
Denver						
≤high school/GED	18	2.96	1.12	84	3.37	.001*
>high school/GED	68	2.16	.83			
Pittsburgh						
≤high school/GED	109	2.96	.90	256	.93	.353
>high school/GED	149	2.85	.85			
Richmond						
≤high school/GED	54	2.90	.80	185	1.62	.108
>high school/GED	133	2.70	.78			

Hypothesis 4

Results from testing the fourth hypothesis, that individuals who self-reported recent cannabis use would be more likely to have higher mean scores on the PPCU than individuals who did not self-report recent cannabis use, are summarized in Table 14. Across the two recruitment sites that assessed recent cannabis use (Denver and Richmond) combined, women reporting recent cannabis use (M = 3.62, SD = .73) had significantly higher mean PPCU scores than women who did not report such use (M = 2.51, SD = .81), $t(270) = 6.83$, $p < .001$. Specifically, women who recently used cannabis were more likely than women who did not to view prenatal cannabis use as safer/more beneficial.

Hypothesis 4 was also tested within both recruitment sites that asked about recent cannabis use (Denver and Richmond), and there was a significant difference in mean PPCU scores by recent cannabis use for both sites. In Denver, women who reported recent cannabis use (M = 3.83, SD = .75) had significantly higher mean PPCU scores than those who did not (M =

2.24, *SD* = .88), *t*(85) = 3.95, *p* < .001, and similarly, in Richmond, women who recently used cannabis (*M* = 3.57, *SD* = .73) had significantly higher mean PPCU scores than women who did not (*M* = 2.65, *SD* = .74), *t*(183) = 5.54, *p* < .001.

Table 14. PPCU Score by Recent Cannabis Use

	N	Mean	SD	Df	t-value	p-value
All Sites Combined						
Recent Use	27	3.62	.73	270	6.83	<.001*
No Recent Use	245	2.51	.81			
Denver						
Recent Use	5	3.83	.75	85	3.95	<.001*
No Recent Use	82	2.24	.88			
Richmond						
Recent Use	22	3.57	.73	183	5.54	<.001*
No Recent Use	163	2.65	.74			

Specific Aim 4: Explore differences in perceptions of cannabis use across three locations

Scores on the PPCU were compared across the three recruitment sites (Denver, Pittsburgh, Richmond), given the differing time points of data collection and status of cannabis legality at time of data collection. Results are summarized in Table 15. A one-way ANOVA revealed that there was a significant difference between the recruitment sites in PPCU scores (*F*(2,538) = 13.64, *p* < .001). A post-hoc Tukey's test showed that the mean value of scores on the PPCU was significantly different between Denver (*M* = 2.34, *SD* = .94) and Pittsburgh (*M* = 2.90, *SD* = .88; *p* < .001), as well as between Denver (*M* = 2.34, *SD* = .94) and Richmond (*M* = 2.76, *SD* = .79; *p* < .001), indicating that women in both Pittsburgh and Richmond were significantly more likely to view prenatal cannabis use as safer/more beneficial than women in Denver. There was no significant difference in PPCU scores between Pittsburgh (*M* = 2.90, *SD* = .88) and Richmond (*M* = 2.76, *SD* = .79; *p* > .05).

Table 15. PPCU Score by Recruitment Site

Recruit Site	N	Mean	SD	Df	F-value	p-value
Denver	88	2.34	.94			
Pittsburgh	265	2.90	.88	2, 538	13.64	<.001*

Richmond	188	2.76	.79			

Additionally, since data at the Pittsburgh location was collected during two separate recruitment periods, scores on the PPCU for this location were also compared between these two time periods. There was a significant difference between women recruited during the first recruitment period (M = 2.77, SD = .85) and second recruitment period (M = 3.31, SD = .87) in PPCU scores $t(263) = -4.27$, $p < .001$, such that women who participated during the second recruitment period were more likely than women who participated during the first recruitment period to view prenatal cannabis use as safer/more beneficial.

Discussion

Summary of Findings

Few previous studies have focused on women's perceptions of the risks and benefits of cannabis use during pregnancy, and the research that does exist lacks reliable, quantitative measures (Skelton et al., 2022a). The present study analyzed data from the PPCU, a measure of attitudes and beliefs of prenatal cannabis use, collected in three different locations (Denver, Pittsburgh, Richmond) across different time points and with varying levels of cannabis legality. The purpose of the current study was to describe perceptions of prenatal cannabis use and cannabis use in general, examine psychometric properties of the PPCU, identify demographic correlates of perceptions of prenatal cannabis use, and explore differences in perceptions of prenatal cannabis use across the three recruitment sites.

The present study found the PPCU to be a reliable measure of perceptions of prenatal cannabis use. As hypothesized, women were more likely to view prenatal cannabis use as safe/beneficial if they were younger, unmarried, and less educated, as well as if they were recent cannabis users. Further, while participants endorsed a mixture of both risks and benefits of

general cannabis use, there was more uncertainty (higher percentage of "don't know/no opinion" responses) when rating the risks and benefits of prenatal cannabis use. Further, when looking across the three sites, women in Denver were more likely to perceive prenatal cannabis use as safe/beneficial than women in Pittsburgh or Richmond.

Specific Aim 1

For general cannabis use, across all three sites, rates of "don't know/no opinion" were generally low (≤16.6%) for the items administered at all recruitment sites. Over 50% of participants agreed with seven out of nine items referring to the safety and benefits of cannabis use generally, including items stating that cannabis helps with stress, takes away aches and pains, helps with headaches, and helps with anxiety. High rates of agreement for these potential benefits of cannabis use is not surprising, given that women are more likely than men to report using cannabis to help with ailments such as nausea, anxiety, and headaches/migraines (Cuttler et al., 2016).

In contrast, for risks of general cannabis use, three of the four items had agreement ratings below 50%, with the fourth item ("Marijuana is addictive") at nearly 50 percent (49.7%). The item with the lowest rate of agreement (13.4%) suggested that cannabis could make people feel sad or depressed, and these perceptions were consistent with individuals' self-reports that, quite the opposite of this item, they may in fact use cannabis to treat their depression (Leung et al., 2022). Overall, participants in the present study more often supported the beneficial effects of general cannabis use, with less support for the risks of general use.

For the 16 PPCU items, across the total sample, rates of "don't know/no opinion" ranged from 20.4% to 42.8%, which was markedly higher than the rates for items assessing perceptions of general cannabis use, indicating a knowledge gap between risks/benefits of general versus

prenatal cannabis use. Notably, for half of the PPCU items, “don’t know/no opinion” was the most common response. This lack of certainty surrounding potential risks and benefits of prenatal cannabis use may be related to the inconsistent literature on the effects of prenatal cannabis use for mother and infant, and methodological issues that limit what is known (Marchand et al., 2022; Skelton & Benjamin-Neelon, 2022). This can result in women receiving insufficient and inconsistent messages about prenatal cannabis use (Barbosa-Leiker et al., 2020; Holland et al., 2016; Jarlenski et al., 2016; Woodruff et al., 2021; Young-Wolff, Gali, et al., 2020). Additionally, fear of legal consequences and stigma may impede patients’ efforts to discuss prenatal cannabis use with their healthcare providers (Woodruff et al., 2021).

Over 50% of participants agreed with two out of the eight items focused on risks of prenatal use, including that it can reach the baby through the placenta and affect the development of the baby. Interestingly, the item stating that prenatal cannabis use can lead to a smaller baby, the finding most supported by the literature (Lo et al., 2022; Marchand et al., 2022), was most frequently answered “don’t know/no opinion” on the survey, further demonstrating the need for more education about increased risk associated with prenatal cannabis use.

For the items assessing potential benefits of prenatal cannabis use, rates of agreement were <50% for all eight items. The two items with the highest rates of agreement stated that cannabis can help with morning sickness and nausea during pregnancy (38.7%) and that cannabis can increase a mother’s appetite during pregnancy (46.1%). The relatively higher rates of agreement for these two items coincides with research showing that one of the most common reasons reported for prenatal cannabis use is the treatment of nausea/vomiting (Barbosa-Leiker et al., 2020; Chang et al., 2019; Daniels et al., 2022; Kiel et al., 2023; Ko et al., 2020; Mark et al., 2017; Young-Wolff, Gali, et al., 2020). Overall, contrary to the items assessing perceptions of

general cannabis use, participants agreed with items describing risks of prenatal cannabis use at higher rates than items describing benefits.

Specific Aim 2

Overall, this study found evidence for PPCU reliability as a measure of prenatal cannabis use perceptions using Cronbach's alpha. However, when calculating McDonald's omega, one item ("Marijuana use during pregnancy can lower mom's blood pressure, which is good for the baby") had to be removed before calculating omega due to its negative covariance with other PPCU items. It is possible that this item's negative covariance with the other items may be due to participants interpreting it differently or responding to different parts of the statement, as it is a double-barreled item. For instance, participants may have selected "agree" to indicate that they agreed that cannabis use during pregnancy can lower mom's blood pressure, or that they agreed that mom having lower blood pressure is good for the baby, or both. This item may have also been confusing for participants if they interpreted it as meaning that cannabis use during pregnancy could lead to low blood pressure for mom, as low blood pressure has been associated with poor perinatal outcomes (Friedman & Neff, 1978).

Significant correlations between an item assessing perceptions of the safety of general cannabis use and an item from the PPCU assessing perceptions of the safety of prenatal cannabis use supported the validity of the PPCU. Specifically, if a participant found cannabis safe to use during pregnancy, they would logically also find it safe to use in the general population. However, no other items on the PPCU could be suitably compared with items about perceptions of general cannabis use, as the remaining PPCU items related so specifically to pregnancy that they could not be appropriately compared to any of the general use items, thus making it difficult to further confirm the validity of the PPCU. Additionally, the overall pattern of results confirms

that participants exhibited greater certainty for items related to general cannabis use than prenatal cannabis use, which does indicate that participants were paying attention to the specifics of what each set of questions were asking and were answering based on their level of knowledge and certainty for each. Future research should have more direct comparisons between the same or similar items for general use and prenatal use.

This serves as an important contribution to the study of prenatal cannabis use, as a reliable, quantitative measure of perceptions of prenatal cannabis use was previously lacking in the literature (Skelton et al., 2022a).

Specific Aim 3

As hypothesized, across the overall sample, women were significantly more likely to view prenatal cannabis use as safe/beneficial if they were younger, unmarried, and less educated. This is consistent with prior research demonstrating that women who are younger, unmarried, and less educated have less knowledge about and lower risk perceptions of prenatal cannabis use (Ng et al., 2022; Odom et al., 2020; Oh et al., 2017). Additionally, prior research has demonstrated that lower perceived risk of substance use is associated with a higher likelihood of use (e.g., Thornton et al., 2013), including for cannabis specifically (Levy et al., 2021; Salloum et al., 2018). Similarly, women with recent marijuana use rated cannabis use as more acceptable compared to women with no recent use (Coughenour et al., 2021). Therefore, the present study findings also align with previous research showing that younger, unmarried, less educated women are more likely to use cannabis during pregnancy (Beatty et al., 2012; Ko et al., 2015; Odom et al., 2020; Oh et al., 2017; Schempf & Strobino, 2008; Skelton & Benjamin-Neelon, 2021; van Gelder et al., 2010; Young-Wolff, Ray, et al., 2021).

Also as hypothesized, at the two sites (Denver and Richmond) that asked about recent cannabis use, women who used cannabis recently were more likely to view prenatal use as safe/beneficial. As almost all the women at these sites were either pregnant or postpartum, it is likely that their recent use occurred during pregnancy. Therefore, this is consistent with prior research that found that women who continue to use cannabis during pregnancy are less likely to report prenatal use as harmful (Ko et al., 2015; Mark et al., 2017) and are often unaware of any risks associated with prenatal use (Chang et al., 2019).

Interestingly, testing of the hypotheses by site yielded some inconsistencies. Younger women were only found to view prenatal cannabis use as safer/more beneficial in Denver. It is possible that the age difference in perceptions of prenatal cannabis use were more pronounced in Denver due to the length of time that recreational cannabis has been legal in the state of Colorado. As Colorado had legalized recreational cannabis in 2012, it had been legal for about three years at the time of data collection in Denver, which means that for younger ($\leq$ 25 years) participants, cannabis had been legal in their state for multiple of their formative teenage/young adult years. Given the perceived reduction in stigma of prenatal cannabis use post-legalization (Young-Wolff et al., 2022), young women in Denver may have been exposed to more positive viewpoints on cannabis use when coming of age in a way that the older participants in Denver may not have been, which may have influenced their perceptions of use during pregnancy and increased the divide in perceptions between age groups.

Additionally, while unmarried women were more likely than married women in Denver and Richmond to view prenatal cannabis use as safe/beneficial, this pattern was not maintained in Pittsburgh. This may be related to the different marital statuses within the category of "unmarried" in the Pittsburgh sample. When dichotomizing marital status, the decision was made

to combine never married, divorced, widowed, and separated into one "unmarried" category, in alignment with previous research examining trends of prenatal cannabis use among married versus unmarried women (Oh et al., 2017). Additionally, while other research on prenatal cannabis use has utilized a distinct marital status category of "divorced, separated, or widowed" (Ko et al., 2015), the small number of participants in the present study at each site that fit into these categories (N = 3 in Denver, N = 25 in Pittsburgh, N = 4 in Richmond) would have not suited analyses for this distinct category within each site, further influencing the decision to dichotomize marital status in the way discussed. However, in grouping this way, a larger proportion of unmarried women in Pittsburgh were widowed, divorced, or separated (as opposed to never married) in Pittsburgh (13%) than in Denver (3%) or Richmond (5%). Past research has demonstrated that previously married women may have better health outcomes than never married women (Waldron et al., 1997). Therefore, possibly, there are also differences between formerly married and never married women in their risk perceptions of prenatal cannabis use that lessened the gap between married and unmarried women in the Pittsburgh sample.

Finally, when examined at individual recruitment sites, women with a lower education level were significantly more likely than women with a higher education level to view prenatal cannabis use as safe/beneficial only in Denver. One potential explanation for the more significant difference in PPCU scores by education level in Denver is that among women with a higher education level (>high school/GED), Denver had a higher proportion of women that had completed a graduate degree (25%) than Pittsburgh (20%) and Richmond (19%). This higher proportion of women who had completed an advanced degree in Denver may have contributed to the significant difference by education level in perceptions of cannabis use, as the women with

higher education levels in Denver may have been more aware of the potential risks of prenatal cannabis use than the women with higher education levels in the other two sites.

Specific Aim 4

When comparisons were made across sites for PPCU scores, women in Richmond and Pittsburgh were more likely to view prenatal cannabis use as safe/beneficial (have higher mean PPCU scores) than women in Denver. This may be surprising when considering that Denver was the only of the three recruitment sites where recreational cannabis use was legal throughout recruitment. Past research has demonstrated that in states with legal cannabis, women have been significantly more likely to use cannabis during pregnancy (Skelton et al., 2020a) , especially when they have legal cannabis retailers nearby (Young-Wolff, Adams, et al., 2021), and that they have perceived a reduction in the stigma associated with prenatal cannabis use post-legalization (Young-Wolff et al., 2022). Therefore, it seems unexpected that women in Denver would view prenatal cannabis use as less safe/beneficial. However, other prior research has shown that women may not report their prenatal cannabis use to their healthcare providers when they fear stigma and legal consequences (Woodruff et al., 2021), and accordingly, women have reported that they feel more comfortable discussing their prenatal cannabis use with their healthcare providers post-legalization (Young-Wolff et al., 2022). Thus, it is possible that women in Denver felt emboldened to discuss prenatal cannabis use with their healthcare providers following legalization and were thus better attuned to the potential risks of prenatal cannabis use than the women in Pittsburgh and Richmond. It is also possible that public health campaigns on cannabis use, and specifically cannabis use during pregnancy (Ghosh et al., 2016), in Denver may have contributed to the differences.

Further, as research has shown that perceived risk of prenatal cannabis use has lessened over time (Alshaarawy & Vanderziel, 2022; Jarlenski et al., 2017), and both Pittsburgh and Richmond had at least some span of recruitment that was more recent than Denver, it is also possible that changes over time contributed to the significant lower perceptions of risk in Pittsburgh and Richmond. This reduction in risk perception over time may also explain why women who participated in the second recruitment period in Pittsburgh were significantly more likely than those in the first recruitment period to view prenatal cannabis use as safe/beneficial.

Study Implications and Applications

The main implication of this study is that women feel more confident in their knowledge related to the risks and benefits of general cannabis use than they do regarding the risks and benefits of prenatal use, given the high rates of "don't know/no opinion" for PPCU items. Especially considering that "don't know/no opinion" was the most common response for over half of the PPCU items, it is apparent that many women do not feel well informed about the potential risks and benefits of prenatal cannabis use, or think that the available data is unclear, emphasizing the need for more education on what the current research shows on outcomes of prenatal cannabis use. One potential way to promote increased knowledge and understanding of the potential risks and benefits of prenatal cannabis use would be for healthcare providers to engage in more education and discussion about this topic with their patients. For instance, obstetric providers could provide women who are pregnant or thinking of becoming pregnant with the necessary information to help them make informed decisions. However, since the first prenatal visit does not occur until well into the first trimester, pre-pregnancy engagement should also be considered. Project CHOICES (Project CHOICES Intervention Research Group, 2003), for example, identified women in community settings that were at-risk of an alcohol-exposed

pregnancy and engaged them in four sessions of motivational interviewing to help them either improve their use of contraception or reduce their alcohol use before becoming pregnant, ultimately decreasing the risk of alcohol-exposed pregnancy. A similar outreach program could be considered for those at risk of in-utero cannabis exposure. Additionally, health communication campaigns could be utilized to communicate the potential negative outcomes associated with prenatal cannabis use by targeting the reasons women may use cannabis during pregnancy, explaining the possible risks of cannabis use during pregnancy, and encouraging women to use medications that have been shown to be safe for use during pregnancy (SAMHSA, 2019).

Additionally, the lack of confidence regarding the risks and benefits of prenatal cannabis use also demonstrates the need for more quality research on the topic. While there have been a few recent meta-analyses on this topic (Lo et al., 2022; Marchand et al., 2022), many of the included studies did not control for co-exposure of other substances and were reliant on self-reported substance use data, making it difficult to draw clear conclusions. In addition, as new research is published, recommendations may change. At present, ACOG (2023) states, "Research is limited on the harms of marijuana use during pregnancy. Because all of the possible harms are not fully known, ACOG recommends that anyone who is pregnant, planning to get pregnant, or breastfeeding not use marijuana." Public health education and outreach should continue to be implemented to educate the public on the potential risks and benefits of prenatal cannabis use and to promote the opinions of experts, such as ACOG, especially given that risk perceptions are constantly shifting with increased legalization and availability. Ideally, the PPCU will be utilized in future research and clinical environments to assess perceptions of prenatal cannabis use. This measure could prove to be especially useful in clinical settings, given that the

findings of this study demonstrated that it may be associated with cannabis use during the perinatal period.

Study Strengths and Limitations

A main strength of this study is that it is the first to the author's knowledge to utilize a reliable, quantitative measure for assessing perceptions of prenatal cannabis use. This study conducted initial psychometric testing on the PPCU, laying the groundwork for this measure to be used in future research. Additionally, this study was comprised of a diverse sample, in terms of age, race, location, marital status, education level, and pregnancy status, and demonstrated that the PPCU is reliable across this diverse group of women.

However, while the heterogeneity of the sample allowed for better understanding of perceptions of prenatal cannabis use across varying perspectives, the large variation in demographic characteristics across sites also made it difficult to attribute differences found between sites to any one component. For instance, it is difficult to tease apart the effects of time of data collection, legalization status of cannabis, and location using the statistical analyses conducted, given that the three recruitment sites differed across all these variables, thus limiting the ability to fully interpret site differences.

Additionally, while allowing participants to select a response option of "don't know/no opinion" for the PPCU items provided valuable information on women's knowledge and certainty pertaining to the risks and benefits of prenatal cannabis use, this also led to fewer responses that could be factored into the PPCU mean scores, as only Likert-style responses from "strongly agree" to "strongly disagree" could be scored in computing this variable. Further, since this response option contained both "don't know" and "no opinion," it is unclear how these different components may have been interpreted by respondents, and whether this too closely

overlapped with the neutral response option of "neither agree nor disagree." Further research may consider either limiting this sixth response option to solely "don't know," or presenting participants with forced-choice Likert scale response options only.

Finally, another limitation of this study is its reliance on self-report measures, especially for questions related to recent cannabis use among the predominantly pregnant and postpartum participants, as self-report measures of prenatal cannabis use have been shown to be unreliable (Skelton et al., 2022b) and may have been impacted by social desirability bias. However, the fact that survey data was collected anonymously at all three sites hopefully mitigated some of this bias.

Future Directions

Future research should continue to examine the psychometric properties of the PPCU, especially its validity, as this study was only able to conduct one validity check that compared one PPCU item to a similar item about general cannabis use. Further research should also implement a factor analysis of the proposed PPCU items to help understand the underlying dimensions of the variables in the PPCU.

Additionally, future research may seek to examine perceptions of prenatal cannabis use in single recruitment sites over time to further examine how perceptions may shift with time and changes in cannabis legalization, without the added confounding variable of differing sites/states. The current findings in comparing PPCU scores between two separate recruitment periods in Pittsburgh demonstrate that there may be changes within one site as time passes and cannabis regulation is liberalized (e.g., shifted from being illegal medically to legal medically). Thus, future research could build upon this by utilizing the PPCU to probe single-site changes in

prenatal cannabis use perceptions over time in other states and under other circumstances for changes in cannabis regulation status, such as shifts to legal recreational cannabis use.

Additional points for consideration in future research on perceptions of prenatal cannabis use include assessing perceptions related to more specific components of prenatal use, such as frequency of use (e.g., daily vs occasionally), quantity of use, mode of administration, and medical versus recreational use. While the current questions in the PPCU assess perceptions of the risks and benefits of prenatal cannabis use, they do not include any questions assessing whether women's perceptions of the safety of cannabis use during pregnancy may alter based on such factors. While there is currently no known safe level of cannabis use during pregnancy, there is research demonstrating dose-dependent outcomes for in-utero exposure to other substances, such as tobacco (Salihu & Wilson, 2007), as well as research showing that women's risk perceptions of prenatal alcohol use vary based on the amount consumed (e.g., Morris et al., 1994). Thus, it is possible that women's perceptions of the safety of prenatal cannabis use may also vary based on frequency and quantity of cannabis use, and future research should explore this. Additionally, while women recruited in Denver were asked questions about their perceptions of cannabis use during pregnancy via differing routes of administration (e.g., whether edibles are safer than smoking cannabis during pregnancy), neither of the other two recruitment sites administered these items, and so future research should continue to explore women's risk perceptions of prenatal cannabis use related to mode of administration across additional recruitment sites and samples. In addition to the PPCU, more qualitative research may also be useful in determining how women's prenatal cannabis use risk perceptions vary related to these factors. Qualitative interviews on perceptions of prenatal cannabis use, such as those conducted by Chang et al. (2019) should be considered for exploring themes in women's

perceptions of cannabis use regarding considerations such as quantity, frequency, route of administration, and reasons for use.

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