

MULTIDIMENSIONAL INFLUENCES ON PRENATAL CANNABIS USE:

A MIXED METHODS STUDY

by

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## ABSTRACT

### MULTIDIMENSIONAL INFLUENCES ON PRENATAL CANNABIS USE: A MIXED METHODS STUDY

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Under the Supervision of Professor Dr. Emmanuel Ngui

**Background:** Rates of prenatal cannabis use (PCU) have more than doubled in recent years, disproportionately impacting birthing people with lower incomes and mental health conditions. Existing PCU research is fragmented, marked by methodological challenges, and constrained by a complicated socio-political landscape. To understand and address PCU, research is needed to (1) measure PCU in a way that reflects real-world patterns, (2) identify multidimensional influences on PCU, and (3) center the perspectives of birthing people who use cannabis.

**Methods:** This mixed-methods study analyzed secondary qualitative and quantitative data from pregnant cannabis users enrolled in a community-based program in Wisconsin. Quantitative data were analyzed longitudinally using generalized estimating equations (GEE), and reflexive thematic analysis was used to analyze qualitative data. A mixed methods convergent parallel design integrated the findings. The study was guided by a new conceptual framework, drawing from the Integrated Behavioral Model and Lifecourse Theory. **Results:** In quantitative analyses, levels of preconception cannabis use and concurrent tobacco use emerged as the most significant predictors of PCU patterns over the prenatal period. Qualitative findings underscored the impact of mental health and stress as primary drivers of PCU. Notably, social factors were influential in both quantitative and qualitative analyses, highlighting their critical role in shaping cannabis use behaviors during pregnancy. **Significance:** This study is one of the

few that used GEE to measure prenatal cannabis use, centered perspectives and experiences of birthing people, and used mixed methods to integrate findings, leading to a more complete picture of this critical maternal and child health issue. The findings from this study carry important implications across several domains, including (1) improving measurement strategies, (2) expanding access to unbiased and scientifically based information, (3) designing equitable clinical and community interventions, (4) cross-sector collaboration, (5) informing policy changes, and (6) prioritizing participatory approaches.

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Dedicated to the pregnant and parenting individuals who participated in this study.

Your courage, honesty, resilience, and love for your children inspire us all.

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## LIST OF ABBREVIATIONS

BIPOC	Black, Indigenous, and People of Color
CHP	Cannabinoid Hemp Products
CTCU	Cannabis Tobacco Co-Use
CUD	Cannabis Use Disorder
GAD-7	Generalized Anxiety Disorder Screener 7-item Scale
HE	Health Educators
IBM	Integrated Behavior Model
GEE	Generalized Estimating Equations
LCT	Lifecourse Theory
NSDUH	National Survey on Drug Use and Health
PCU	Prenatal Cannabis Use
PCUF	Prenatal Cannabis Use Frequency
PHQ-9	Patient Health Questionnaire 9-item Scale
PRAMS	Pregnancy Risk Assessment Monitoring System
RTA	Reflexive Thematic Analysis
SAMHSA	Substance Abuse and Mental Health Services Administration
SMC	Synthesized Member Check
THC	Delta-9-Tetrahydrocannabinol
TLFB	Timeline Follow Back

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## Chapter 1. Introduction

### Prevalence and Trends

Rates of prenatal cannabis use (PCU) have more than doubled in recent years, with an estimated eight percent of birthing people reporting use in 2022.<sup>1-3</sup> Rates of cannabis use disorder (CUD) have increased nearly five-fold over the past several decades<sup>4</sup> with an estimated 18% of pregnant cannabis users meeting the CUD Diagnostic and Statistical Manual of Mental Disorders (DSM)-5 criteria.<sup>5,6</sup> These prevalence rates are considered underestimates, as rates are consistently higher in clinical settings than in population-based surveys like the National Survey on Drug Use and Health (NSDUH) and the Pregnancy Risk Assessment Monitoring System (PRAMS).<sup>7-9</sup> Additionally, several studies have demonstrated discrepancies between PCU self-report and biochemical verification, such as urine toxicology or infant meconium testing,<sup>9-11</sup> with one cohort study indicating that PCU self-report and biochemical verification only matched about half the time.<sup>9</sup>

These trends are typically explained by changes in the legal landscape, increasing accessibility, and increasing social acceptability of cannabis. For example, rates of PCU are consistently higher in states where cannabis has been legalized for adult use (also known as non-medical or recreational use) compared with states where adult use remains illegal.<sup>2,12,13</sup> In terms of accessibility, closer proximity to cannabis retailers and greater retail availability are associated with greater odds of PCU.<sup>14</sup> Additionally, among people of reproductive age, perceptions that moderate cannabis use has “no risk” increased from less than five percent in 2005 to 20% in 2019.<sup>15,16</sup> While compelling, the extent to which these trends indicate an actual

increase in prevalence or other factors, such as increased screening, testing, and disclosure, is unknown.

### **Pharmacokinetics**

Cannabis contains over 100 cannabinoids, the most well-known of which is Delta-9-Tetrahydrocannabinol (THC). This psychoactive chemical binds to cannabinoid receptors in the brain and impacts coordination, time perception, thinking, concentration, and memory.<sup>17</sup> During pregnancy, THC and metabolites freely pass through the placenta, enhancing placenta barrier permeability,<sup>18</sup> and affecting maternal, uterine, and placental blood flow.<sup>19,20</sup> THC is highly lipophilic and is thought to accumulate in the brain and fat of the fetus.<sup>21,22</sup>

Preclinical and human studies have shown that prenatal THC exposure dysregulates the fetal endocannabinoid system (ECS).<sup>22,23</sup> This presents a growing concern as the ECS plays a key role in embryo and fetal development, placentation, metabolism, and brain structuring and functioning across several regions.<sup>21,24</sup> Neuroimaging studies of fetuses, infants, and older children support these findings, showing altered neural development and brain changes in certain parts of the brain with more cannabinoid receptors like the hippocampus and prefrontal cortex.<sup>21</sup> Recent research also indicates alterations in DNA methylation at genes involved in neurodevelopment in people who were exposed to cannabis prenatally, with effects persisting through to adulthood.<sup>25</sup>

### **Health Effects**

#### **Challenges**

Determining the independent effect of PCU on neonatal and birth outcomes is difficult to ascertain. PCU research often uses “ever exposed,” a binary measure that doesn’t account

for wide variations in frequency, dose, or timing. Additionally, this commonly used measure doesn't account for the concentration and ratio of cannabinoids, a particular concern given the average THC potency has nearly doubled in the past decade.<sup>26</sup> Additionally, THC can be administered through multiple methods, including smoking, vaping, consuming edibles and drinks, dabbing (highly concentrated THC heated over an open flame), applying topicals, and more. Exposure to other compounds, including pesticides, solvents, inorganics, microbes, and mycotoxins, can occur depending on the route of administration.<sup>27,28</sup> For example, smoking cannabis produces high levels of carbon monoxide,<sup>29</sup> a known neurotoxin associated with a range of adverse fetal outcomes.<sup>30</sup> While most PCU literature focuses on THC-containing products, few studies have sought to understand the impact of other cannabinoid hemp products (CHP) like Cannabidiol, Delta-8 tetrahydrocannabinol, hexahydrocannabinol, hexahydrocannabinol acetate, and hexahydrocannabiphorol, just to name a few.

### **Effects on Birth Outcomes**

Despite these challenges, numerous studies have attempted to isolate the impact of prenatal cannabis exposure on birth outcomes, with differing and sometimes conflicting results. Several meta-analyses published in the mid-to-late 2010s tried to make sense of the earlier literature; however, the findings conflicted. Some identified an association between PCU and adverse birth outcomes,<sup>31,32</sup> while others attributed these associations to tobacco and other confounders.<sup>33</sup>

In 2017, the National Academies of Sciences, Engineering, and Medicine published a rigorous review of the health impacts of cannabis. This report demonstrated conclusive evidence linking PCU to lower birth weight; however, the effect on other birth outcomes remained

unclear.<sup>17</sup> Since that publication, an increasing body of evidence has shown PCU to be independently associated with low birth weight,<sup>17,34,35</sup> small for gestational age,<sup>34,35</sup> preterm birth,<sup>34,35</sup> NICU admissions,<sup>34</sup> and perinatal mortality.<sup>35</sup> Additionally, emerging evidence points towards a dose-response relationship between PCU and birth outcomes. For example, one study of over 5,000 birthing people found that high-frequency cannabis use doubled the risk of low birth weight, while low-frequency use did not increase risk.<sup>36</sup> Length of exposure appears to be a factor, with one study finding a higher risk for adverse outcomes among those who used cannabis beyond the first trimester.<sup>37</sup> Prospective studies have also found a dose-response effect with growth reduction more pronounced among fetuses exposed continuously over the prenatal period.<sup>20</sup>

Differences in the severity of adverse birth outcomes are also found when using other cannabis-related measures. One study found that infants born to birthing people with CUD were more likely to experience a range of outcomes such as small for gestational age, preterm birth, low birth weight, and infant death compared to infants born to birthing people without CUD.<sup>4</sup>

### **Long-Term Effects**

The PCU literature suggests a wide range of adverse physiological, neurodevelopmental<sup>38</sup>, and psychopathological effects<sup>39</sup> on children who were exposed to cannabis prenatally. Three prospective longitudinal cohort studies (the Ottawa Prenatal Prospective study, Maternal Health Practices and Child Development study, and Generation R) have linked PCU with increased aggression, inattention, impulsivity, and hyperactivity, as well as deficits in visual reasoning, memory, language comprehension, executive functioning, and academic achievements in exposed offspring.<sup>40–42</sup> As children progress beyond childhood,

these impacts persist. The Adolescent Brain Cognitive Development (ABCD) study, for example, has demonstrated that PCU is associated with offspring rule-breaking behavior, aggressive behavior, social problems, thought problems, attention deficits, and conduct problems.<sup>39</sup>

Given the challenges with PCU measurement bias, residual confounding, and environmental influences, these findings should be interpreted cautiously. For instance, two recent studies utilized data from a cohort of 200,000 mother-child pairs to examine the association between PCU and (1) autism spectrum disorder and (2) developmental delays, including speech and language disorders, motor delays, and global developmental delays. Although the authors found no significant associations, both studies assessed prenatal exposure using a binary classification (exposed/not exposed) based on a single measure taken at initial prenatal care (8–10 weeks gestation), which does not capture wide variations in frequency and length of exposures.<sup>43</sup>

It is also important to consider that associations between PCU and neurodevelopmental effects may be explained by shared genetic vulnerabilities for both parental cannabis use and behavioral issues.<sup>44</sup> Intergenerational impacts of PCU are another important consideration when interpreting these findings, as several studies have shown that offspring who were exposed to cannabis prenatally are more likely to use cannabis at earlier ages than those not exposed.<sup>45,46</sup>

## **Influences on PCU**

### **Demographic Influences**

Certain populations are more likely to use cannabis during pregnancy than others. People with lower socioeconomic status (SES) use cannabis at significantly higher rates than those with

higher SES,<sup>5,9,12,13,47-52</sup> with one study showing a steady increase in PCU prevalence as income decreased.<sup>53</sup> Age at pregnancy is also consistently associated with PCU, with significantly higher rates of cannabis use among adolescents and young adults.<sup>2,47,52,54</sup> Both PCU frequency<sup>50</sup> and cannabis use disorder (CUD) prevalence<sup>55</sup> were also higher among younger people. A longitudinal study examining cannabis use patterns over nearly two decades found that people who became pregnant earlier in life were more likely to become chronic cannabis users.<sup>45</sup> Similarly, relationship status has been consistently associated with PCU,<sup>2,12,13,56</sup> with unmarried people two and a half to four times as likely to report any use<sup>5,2</sup> and continued cannabis use during pregnancy compared with married people.<sup>12</sup>

It remains unclear if racial differences in PCU rates exist. For example, some studies indicate lower PCU rates among Non-Hispanic Black people<sup>2,47,57</sup> while others indicate a *higher* PCU prevalence among Black birthing people compared with other races,<sup>48,53</sup> while other studies find no impact of maternal race on PCU at all.<sup>45</sup> These discrepancies likely result from bias in measurement, testing, and disclosure. For example, a large study using hospital discharge data found that Black birthing people were tested at twice the rate of non-Hispanic whites.<sup>51</sup> A retrospective cohort study also found that while Black pregnant people were more likely to self-report use than Whites, they were not more likely to have screened positive.<sup>58</sup>

### **Psychosocial Influences**

In population-based studies, mental health comorbidities are consistently and strongly associated with PCU.<sup>2,55-57,59-61</sup> For example, pregnant people who experienced a major depression episode or serious psychological distress had three to four times the odds of PCU compared to people without.<sup>59,61</sup> Depressive symptoms<sup>9,60</sup> chronic depression,<sup>45</sup> and higher

depression and anxiety scores<sup>61</sup> were all associated with increased PCU. Discharge data from nearly 21 million pregnant people found that depression, anxiety, trauma, and ADHD were all higher in pregnant people with CUD, even after controlling for other substance use disorders.<sup>55</sup>

### **Co-use Influences**

While the use of any other substance is associated with PCU,<sup>2</sup> the literature demonstrates a strong and consistent association between tobacco use and higher rates of any prenatal use,<sup>2,5,47,48,52,54</sup> higher rates of continued use,<sup>12,62</sup> and greater frequency of cannabis use.<sup>50</sup> This is of particular concern given that tobacco-cannabis co-use (CTCU) poses a greater risk to infants than using either substance individually, suggesting a synergistic effect.<sup>63</sup> For example, the risk of small for gestational age,<sup>64</sup> small head circumference,<sup>65,66</sup> low birth weight,<sup>66</sup> preterm birth,<sup>64,66</sup> congenital disabilities,<sup>65</sup> and neonatal and infant death<sup>64</sup> are higher among co-users when compared to either substance alone.

### **Historical, Social, and Political Influences**

Historical, social, and political influences on PCU must also be considered. For over 50 years, cannabis was federally classified as a Schedule I drug, defined as high potential for addiction and no accepted medical use, under the Controlled Substances Act (CSA). The CSA was the precursor to the so-called “War on Drugs,” a series of criminalizing laws, enforcement-based approaches, drug-related arrests, and incarceration that disproportionately targeted people of color.<sup>67,68</sup> In October 2022, President Biden announced a federal cannabis policy reform, pardoning federal simple possession offenses and encouraging states to do the same. He also officially recommended to the Drug Enforcement Agency (DEA) and Health and Human Services (HHS) that marijuana be reclassified from Schedule I to Schedule III under federal law.<sup>69</sup> In 2023,

HHS officially recommended reclassification<sup>70</sup> and in 2024, the DEA announced its decision to reclassify marijuana from Schedule I to Schedule III under the Controlled Substances Act.

Throughout these fifty years, states have forged their own cannabis policies through a mix of decriminalization, medical use, and adult (recreational) use legalization efforts, resulting in a complicated patchwork of state-level policies. As of fall 2024, about half the states in the US have fully legalized cannabis. The remaining states have varied policies, including medical use, decriminalized adult use, CBD-only use, and a few states where cannabis is fully illegal.<sup>71</sup>

While liberalization of cannabis policies at the federal and state level theoretically provides enhanced criminal protections for adults, it does little to address the criminalization of substance use during pregnancy. In the 1980s, a series of misguided studies found deficits among cocaine-exposed infants, leading to the “crack baby” myth. Follow-up studies swiftly debunked the severity of this effect,<sup>72</sup> however, decades of racist beliefs and stigmatizing practices around substance use remained in its wake. These findings led states to enact child welfare statutes and reporting requirements that criminalize substance use during pregnancy. As of Fall 2024, in about half the states in the US, substance use during pregnancy is still considered child abuse under civil child welfare statutes, and in five states, it is grounds for civil commitment.<sup>73</sup> Additionally, in about half the states, healthcare providers are required to report suspected prenatal substance use. In eight states, providers are required to test pregnant people even if substance use is suspected.<sup>73</sup>

A recent report from Pregnancy Justice investigated 210 pregnancy-related prosecutions between June 2022 and June 2023. Of the 210 cases, 203 involved substances, and in 133 of those cases, substance use was the only allegation. Eight-six of these cases involved prenatal

cannabis use, and in more than a third of those cases, the *only* allegation supporting prosecution was cannabis use.<sup>74</sup>

These findings are particularly concerning given the well-documented structural bias and racism in the PCU literature, child welfare, and healthcare systems, which unfairly target birthing people of color. For example, an observational study conducted in a clinical setting found that Black birthing people were almost ten times as likely to receive punitive counseling than Whites.<sup>75</sup> Additionally, Black infants were more than four times more likely to be reported to Child Protective Services for prenatal substance use than Whites despite similar rates of use.<sup>76</sup>

An additional structural factor to consider is the exponential growth of the cannabis industry, which is expected to surpass \$40 billion at the end of 2024.<sup>77</sup> While some of the revenue is generated from medical and pharmaceutical use (Marinol and Syndros to treat nausea in chemotherapy patients and anorexia in AIDS patients, Cesamet to treat nausea and neuropathic pain, and Epidiolex to treat a rare form of pediatric epilepsy),<sup>78</sup> the vast majority of cannabis products on the market are classified as non-medical use.

Mergers between cannabis and big tobacco and alcohol are becoming commonplace. For example, Altria, the world's largest tobacco company, recently made a \$1.8 billion investment in a Canadian cannabis company.<sup>79</sup> It is well documented that Altria and other big tobacco companies continue to employ predatory marketing practices to profit off low-income people, people of color, and other vulnerable populations.<sup>80</sup>

In recent years, there has also been an explosion of psychoactive cannabinoid-hemp products (CHP) fueled by regulatory gaps in the 2018 Farm Bill. A qualitative review of available cannabis-derived products, for example, found 111 unique cannabinoids across 84 different

product types.<sup>81</sup> These products are not subject to quality and safety guidelines, and the potential health effects are largely unknown, raising significant concerns for pregnant users.<sup>82</sup>

## **Gaps**

The PCU literature is fragmented, and significant gaps remain. Much of the existing literature continues to measure PCU in a binary way: either the pregnant person used or didn't use cannabis. In such studies, a pregnant person who used cannabis once, socially, in edible form would be grouped with a pregnant person who smoked cannabis multiple times a day throughout their entire pregnancy. Additionally, PCU is often measured at a single time point, which doesn't account for changes to use over the prenatal period or real-world patterns of use. For example, in qualitative studies, between 60-70% of cannabis users report quitting during pregnancy, and approximately 30-40% continue to use throughout their pregnancies.<sup>12,62,83-90</sup> Oversimplifying PCU in this way does not account for wide variations in use, like timing and dose of exposure, which play an essential role in infant and maternal health outcomes.<sup>91</sup>

Other key influences of PCU – such as mental health and tobacco use – also change over the prenatal period but are often measured at a single time point. Furthermore, the reasons for these associations, nor their effect on cannabis use patterns over the prenatal period, are not well understood. Other potentially important influences on PCU, like social influences, have been studied at length in adolescent populations but have not been examined in prenatal populations. Moreover, PCU findings are often not situated within important historical, political, and structural contexts.

Birthing people's perspectives and descriptions of their experiences are key to understanding and addressing PCU. While there have been a handful of qualitative studies on

PCU, most focus on a single domain (e.g., healthcare experiences, risk perceptions) rather than a multidimensional approach. Several qualitative studies use the same sample of birthing people, and most are set in states where cannabis has been fully legalized, further limiting diverse perspectives.<sup>83,90,92–96</sup> Moreover, the absence of mixed methods approaches and lack of theoretical frameworks represent additional gaps, resulting in a fragmented and incomplete understanding of this issue.<sup>16,84</sup>

### **Purpose**

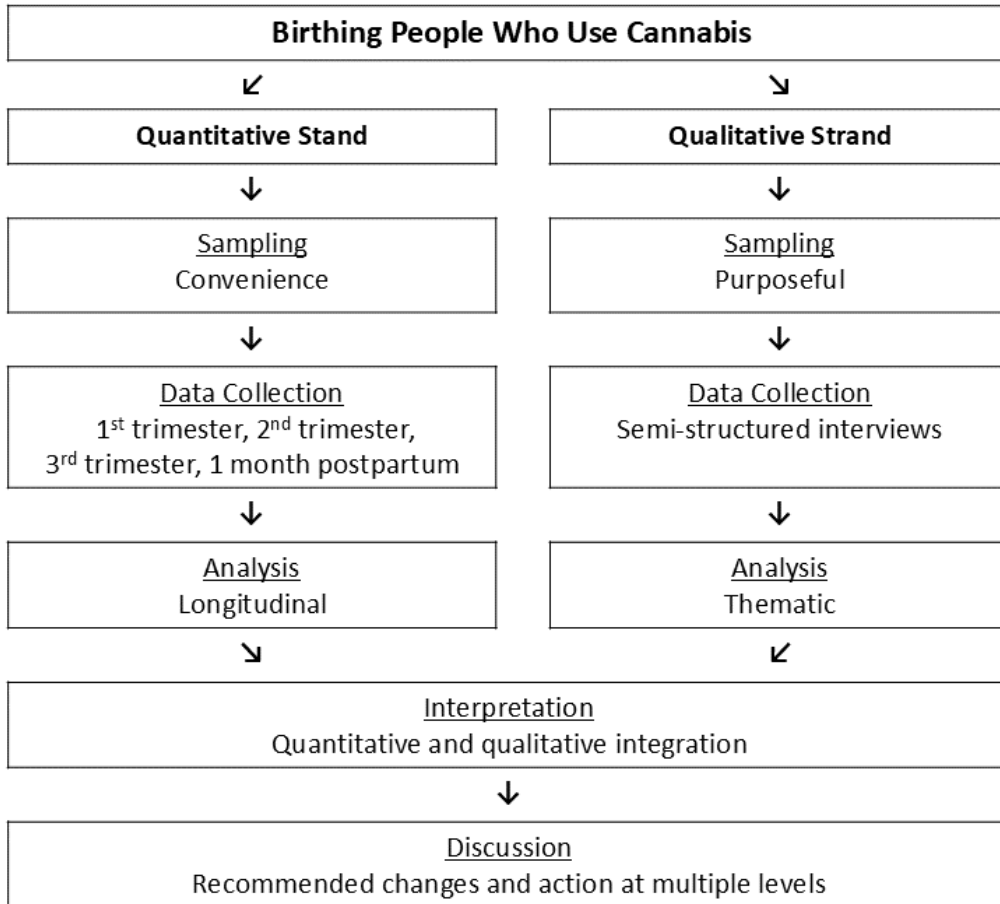
The overall purpose of this mixed-methods study was to examine multidimensional influences on prenatal cannabis use, centering the perspectives and experiences of birthing people. A mixed-methods approach provided a more complete, comprehensive, and compassionate understanding of a complex maternal and child health issue. A new conceptual model is proposed, integrating an individual-level behavior model and structural theory. The results of this study may be used to develop effective, appropriate, non-punitive prenatal cannabis prevention, intervention, and policy efforts that protect and promote the health of pregnant people, infants, and children.

### **Design**

This mixed-methods study used secondary quantitative and qualitative data collected concurrently from birthing people who used cannabis during their pregnancies. A convergent parallel design was used to compare qualitative and quantitative datasets and interpret where the data converged, diverged, or were contradictory.<sup>97</sup> As shown in Figure 1, both datasets remained independent during the data collection and analysis phase and were only mixed during the overall interpretation.<sup>98,99</sup> Additionally, quantitative and qualitative data were

weighted equally, allowing participants' voices and experiences to be highly valued and visible.<sup>99</sup>

**Figure 1.** Procedural Diagram of Mixed Methods Study of PCU



**Mixed Methods Justification**

A mixed methods approach was used to systematically integrate quantitative and qualitative methods and obtain a fuller picture and deeper understanding of this complex maternal and child health issue.<sup>98,99</sup> This approach aims to go beyond just combining two methods and brings together different philosophies, sometimes referred to as the third path,<sup>100</sup> providing more breadth, meaning, and explanatory power than a single method.<sup>100</sup>

A mixed-methods design was selected to address this topic for four reasons. First, PCU is a complex public health issue; multiple techniques and approaches are needed to obtain a more complete and comprehensive understanding. Second, a mixed-methods approach offsets the weaknesses of a single-method approach.<sup>98</sup> For example, qualitative data lacks the ability to test for associations and control for confounding variables. Quantitative data lacks the nuance of birthing people's explanations of those predictors, patterns, and relationships. Combining the methods offsets these weaknesses, strengthening the overall design and validity. Third, a qualitative component was essential to contextualize people's experiences and to address structural and political influences on cannabis use during pregnancy.<sup>95,101-103</sup> Finally, using mixed methods design filled a large gap in existing PCU research, where mixed methods are rarely used.

### **Quantitative Component**

The quantitative component of this study provided detailed data on birthing people's cannabis use throughout the prenatal period. A longitudinal approach was used to examine changes in prenatal cannabis use frequency (PCUF) at three time points: first trimester, second trimester, and third trimester which correspond to when the assessments were done. Generalized estimating equations (GEE) were employed to analyze repeated measures of PCUF, accounting for within-subject correlation and interactions between predictors of interest and time. Additionally, the quantitative component allowed for the examination of multiple variables of interest across multiple domains: behavioral, cognitive, psychological, social, and structural.

## **Qualitative Component**

The qualitative component of this study used reflective thematic analysis (RTA) to describe birthing people's perspectives on behavioral, psychosocial, and structural influences on their cannabis use using a lifecourse perspective. RTA is a methodology that emphasizes theoretical flexibility, pattern identification, and researcher reflexivity.<sup>104</sup> RTA was selected as the approach to (1) promote the dignity, autonomy, and voices of birthing people who use cannabis, (2) to highlight the diverse perspectives and experiences of birthing people, (3) to expose and address biases and limitations of past PCU research, and (4) to highlight the structural drivers of PCU.<sup>105</sup> Researcher bias, power, and narrative shaping were continuously examined using a reflexivity process. A critical realist framework was used during the analytic process, staying close to participants' accounts of their experiences situated within historical, local, and policy contexts.<sup>106</sup>

Domains examined in the qualitative portion of this study included: (1) early cannabis exposure and initiation, (2) changes to cannabis use during pregnancy, (3) cannabis-tobacco co-use, (4) connections between mental health and cannabis, (5) connections between stress and cannabis, (6) social influences on cannabis, (7) experiences of stigma and discrimination, and (8) commercial and policy influences on cannabis use. A full list of quantitative and qualitative measures used in this dissertation can be found in Appendix A.

## **Research Aims**

To achieve the purpose of this research study, the following aims were formulated:

1. Examine the most significant, multidimensional influences on cannabis use patterns over the prenatal period,

2. Describe birthing people’s perspectives on the behavioral, psychosocial, and structural influences on PCU,
3. Examine cannabis-tobacco co-use beliefs, behaviors, and experiences,
4. Determine the extent to which quantitative and qualitative findings are convergent, divergent, or contradictory, and
5. Assemble a final conceptual model illustrating the most salient multidimensional influences on prenatal cannabis use.

Table 1 provides an overview of the operational definitions used in these research aims.

**Table 1.** Operational Definitions

<b>Term</b>	<b>Operational Definition</b>
Birthing People	Refers to the pregnant individuals who participated in this study. Gender data was not collected so a more inclusive term was used.
Cannabis	Refers to psychoactive products containing THC.
Cannabinoid hemp products (CHP)	Refers to psychoactive products containing other cannabinoids, such as delta-8 tetrahydrocannabinol.
Cannabis Use Patterns	Refers to changes in cannabis use frequency over the prenatal period.
Prenatal Cannabis Use (PCU)	Any cannabis use during the prenatal period.
Prenatal Cannabis Use Frequency (PCUF)	Past 30-day cannabis use; a continuous measure from 0 to 30.
Prenatal Period	Any time between conception and delivery.

The first three aims were aligned with individual manuscripts, each characterized by distinct designs, research questions, and hypotheses. The aims are briefly outlined below, with the full manuscripts presented in Chapters 2 through 4. Aim four involved an integrative process, while aim five entailed the development of a final conceptual model. Both aims are briefly summarized below and discussed in greater detail in Chapter 5 of this dissertation.

### ***Aim 1***

Aim one investigated the multidimensional influences on prenatal cannabis use patterns over the prenatal period in a manuscript entitled “Influences on cannabis use trends during pregnancy: A longitudinal study of low-income, pregnant cannabis users.” This aim included research questions about (1) the overall trend of PCUF over the prenatal period, (2) whether PCU trends differed based on certain risk factors across multiple domains, and (3) whether higher risk factors were associated with a decreased likelihood of a downward PCU trend during pregnancy. Demographic, substance use, psychological, and social factors were examined. This manuscript can be found in chapter two of this dissertation.

### ***Aim 2***

The purpose of aim two was to describe birthing people’s perspectives on the behavioral, psychosocial, and structural influences on PCU. This aim was addressed in a manuscript entitled “Multidimensional influences on prenatal cannabis use: A reflexive thematic analysis.” The research question was answered by collecting, analyzing, and interpreting qualitative data to understand influences on PCU in eight domains. This manuscript can be found in chapter three of this dissertation.

### ***Aim 3***

The focus of aim three was to understand prenatal cannabis-tobacco co-use (CTCU) in a manuscript entitled “A mixed methods study of prenatal cannabis and tobacco co-use beliefs, behaviors, and experiences.” This was a mixed methods study, employing a convergent parallel design, examining (1) the top reasons for tobacco and cannabis use during pregnancy, (2) whether reasons for use influence quit outcomes, (3) differences and relationships between quit intentions, attempts, and outcomes by substance, (4) differences and relationships between quit intentions, attempts, and outcomes by co-use category, and (5) how birthing people describe their co-use beliefs, behaviors, and experiences. This manuscript can be found in chapter four of this dissertation.

### ***Aim 4***

Aim four integrated the qualitative and quantitative findings by determining the extent to which quantitative and qualitative findings converged, diverged, or were contradictory. This integration occurred after qualitative and quantitative data were analyzed separately in line with the parallel convergent design. Results are organized using the domains identified in the a priori conceptual model and summarized in narrative form and using a matrix technique, a method used to visualize the integration of quantitative and qualitative data concisely.<sup>97</sup> The integration process and final interpretation are described in Chapter 5.

### ***Aim 5***

Aim five was to assemble a final conceptual model illustrating the most salient multidimensional influences on prenatal cannabis use. An a priori conceptual model was constructed to illustrate the most salient factors influencing prenatal cannabis use based on

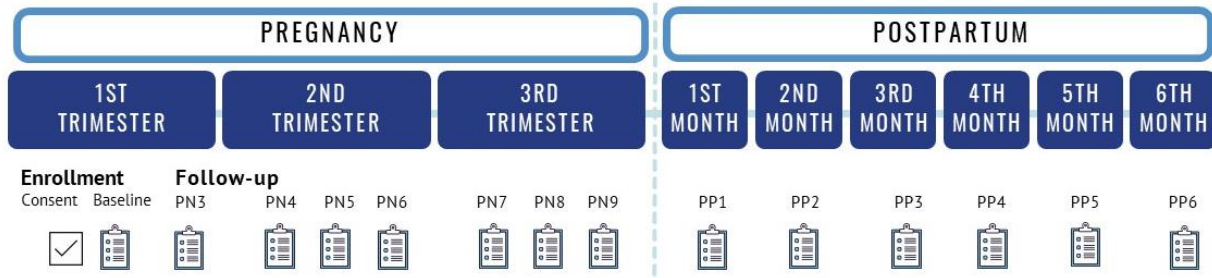
existing literature, which had significant limitations. This dissertation used mixed methods to examine these factors in a deeper, more nuanced, and contextualized way. The findings were used to update the final conceptual model. This process and the final model are described in Chapter 5.

### **Study Setting**

This study used secondary quantitative and qualitative data from birthing people who participated in the First Breath program between January 2022 and December 2023. First Breath is a free, statewide program in Wisconsin that helps people make positive changes to their tobacco, alcohol, cannabis, and other substance use during pregnancy and beyond. First Breath was established as a perinatal tobacco program in 2002 and expanded to address all perinatal substance use in 2022. First Breath uses a two-step model to address perinatal substance use. In step one, First Breath partners with nearly 300 agencies throughout the state, including Women, Infants, and Children (WIC) sites, Prenatal Care Coordination (PNCC) programs, OB/GYN clinics, local health departments, federally qualified health centers, tribal health clinics, and others. First Breath is available statewide, with at least one First Breath site in each of Wisconsin's 72 counties. First Breath trains perinatal healthcare providers at these sites to use the Ask-Advise-Refer model to identify pregnant people who use substances, provide brief interventions, and refer them to First Breath. Ask-Advise-Refer is a variation of Screening, Brief Intervention, and Referral to Treatment (SBIRT), a public health approach recommended by the Substance Abuse and Mental Health Services Administration (SAMHSA) to identify risky substance use in clinical and community-based settings.<sup>107</sup>

In step two, referred individuals are matched with one of five local First Breath Health Educators (HEs), highly trained health professionals who provide evidence-based and -informed harm reduction and cessation services. HEs are bachelor and master’s prepared professionals who hold certificates in substance use disorder counseling and perinatal mood disorders. HEs use Motivational Interviewing to provide participant-centered, trauma-informed, and strength-based coaching that builds participants’ coping, stress management, and communication skills to help them reach their substance use-related goals. Services include text message support and one-to-one monthly phone and virtual coaching sessions from enrollment (typically first trimester) through six months postpartum, as shown in Figure 2.

**Figure 2.** Timeline of First Breath Services



Abbreviations: PN, prenatal; PP, postpartum

The First Breath program has more than twenty years of experience handling, storing, and securing the protected health information of birthing people who use substances. First Breath has also previously partnered with academic partners in two randomized controlled trials,<sup>108,109</sup> further demonstrating the capacity to collect and store PHI.

### Research Team

This study was led by Kristine Alaniz (KA), a doctoral candidate and a Master of Public Health (MPH)-prepared public health practitioner with over twenty years of experience. From

2012 to 2023, KA managed the First Breath program. Upon her departure from her role in December 2023, a data use agreement was obtained granting permission for KA to analyze program data as part of her dissertation requirements.

All quantitative and qualitative data used in this study were previously collected by five First Breath Health Educators (HEs) as part of standard program operations. All individuals collecting and handling participant data engaged in a reflexivity practice, using journaling, case notes, and team meetings to reflect upon experiences, record important contextual information, and identify potential biases. The University of Wisconsin—Milwaukee IRB reviewed this study in February 2024, and it deemed it exempt due to its exclusive use of deidentified secondary data.

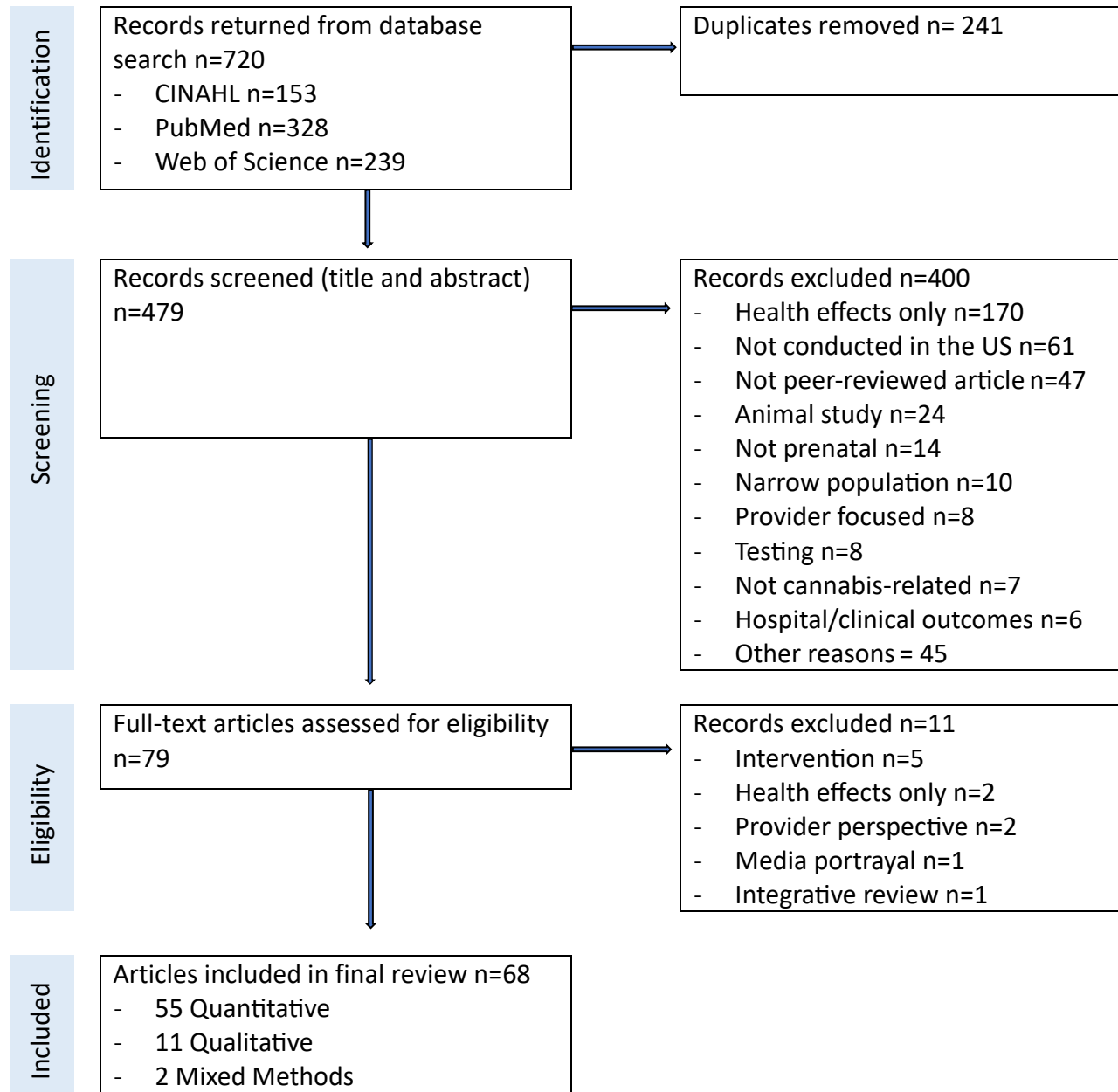
### **A Priori Conceptual Framework**

An a priori conceptual model was created to guide this dissertation's design, measurement strategy, and interpretation of findings. The initial components of the model were selected based on an integrative review conducted in Fall 2023. The purpose of the integrative review was to assess the current body of evidence regarding multi-level influences on prenatal cannabis use. An integrated, mixed methods approach was used to synthesize literature published in the U.S. from 2013-2023. Data were analyzed using a results-based convergent synthesis design. As shown in Figure 3, a total of 68 studies (55 quantitative, 11 qualitative, and two mixed methods) met the inclusion criteria and underwent full review.

The review illuminated significant limitations in the current state of the PCU literature, such as measurement bias, a lack of mixed-methods approach, and limited inclusion of birthing people's perspectives. However, within those constraints, many factors were consistently

associated with PCU. These factors were grouped by six distinct levels of influence and arranged into the conceptual framework.

**Figure 3.** Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)



- Examples include opinion pieces, committee opinions, and letters to the editor.
- Studies restricted to pregnant people diagnosed with/experiencing HIV+, opioid or other substance use disorder, disability, or obesity.
- Other reasons (each with five or fewer studies) include case studies, chemical analysis, epigenetics, immune response/functioning, published before 2013, prevalence only, patent, pathophysiology, pharmacology/kinetics, recommendations, and treatment of cannabis use disorder.

The conceptual model was assembled by integrating an individual-level behavior change model, the Integrated Behavior Model (IBM), and a structural model, Lifecourse Theory (LCT). These two theories were selected based on (1) their alignment with the most salient influences on PCU identified in the integrative review and (2) previous use of these models to address PCU,<sup>110</sup> maternal and child health issues,<sup>111</sup> and substance use more broadly.<sup>112</sup>

IBM is a multi-model theory drawing from two earlier behavior models: the Theory of Reasoned Action and the Theory of Planned Behavior. These models posit that individuals' attitudes, beliefs, and motivations determine behaviors. IBM theorizes that behavioral intention is the most important construct determined by attitude, perceived norm, and personal agency.<sup>113</sup> In the IBM model, individual factors are also influenced by environmental factors such as the individual's knowledge and skills, salience of the behavior, structural/systems constraints, and past performance.

LCT is both a theory and approach that describes the interplay of accumulating factors that shape people's lives and place their behaviors within social and historical contexts.<sup>111</sup> Glen Elder originally described the five fundamental principles of life course theory as (1) time and place, (2) lifespan development, (3) timing, (4) agency, and (5) linked lives.<sup>114</sup> Time and place describe how individuals are situated in historical, social, and cultural contexts. Life-span development refers to the lifelong process of human development. Timing refers to the behavioral patterns, life transitions, and trajectories (long-term patterns) of people's lives. Agency describes the choices and actions individuals engage in within the constraints and opportunities of individuals' circumstances. Linked lives refer to how individuals are inextricably linked to others through relationships and society.

Critical constructs from IBM examined in this study include behavioral intention (intent to change cannabis during pregnancy), attitude (beliefs about PCU), habit (cannabis use patterns before and during pregnancy), and social norms (social influences on whether to use cannabis during pregnancy). The construct of “social norms” is further broken down into injunctive – what other people think about the individuals’ cannabis use – and descriptive – the individual’s perceptions about other people’s cannabis use.

Critical constructs from LCT explored in this study include timing (when and what is going on when the pregnancy occurred), cumulative disadvantage (socio-economic status, mental health conditions), linked lives (social influences on cannabis use), early programming (early cannabis exposure and initiation), trajectories (long-term patterns of cannabis use), and transition (a brief timeframe embedded within the trajectory, in this case, pregnancy).

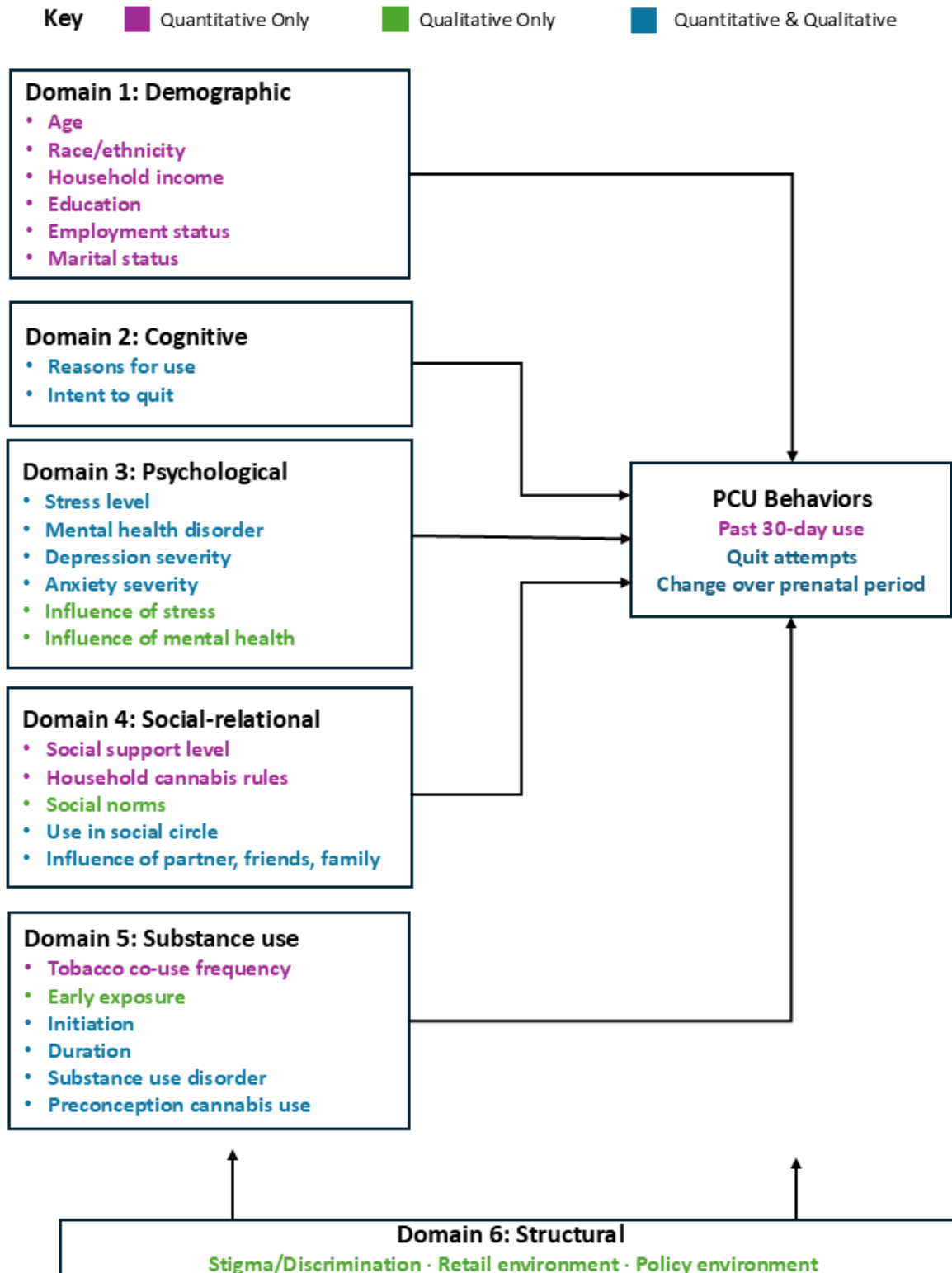
Two constructs appear in both IBM and LCT and serve as the link between the two theories. These include (1) agency, which is referred to as “personal agency” in IBM and “human agency” in LCT, and (2) structural factors, referred to as “environmental constraints” in IBM and “time and place” in LCT. Agency refers to behaviors and decisions birthing people make about their cannabis use and is explored both qualitatively and quantitatively. LCT defines structural factors as how individuals are situated within historical, social, and cultural contexts. IBM defines this as the factors that constrain a person’s behavioral performance. These constructs were examined in the qualitative component of this study.

An a priori conceptual model was constructed to organize this study's constructs and related measures. As shown in Figure 4, the measures examined in this study were arranged into six domains: (1) demographic, (2) cognitive, (3) psychological, (4) social, (5) substance use,

and (6) structural. The demographic domain included age, race/ethnicity, household income, education, and employment status. The cognitive domain included reasons for use, intent to quit, and quit challenges and successes. The psychological domain included stress level, the impact of stress on cannabis, mental health conditions, the effect of mental health on cannabis, and anxiety and depression severity. The social domain included relationship status, social support level, household cannabis rules, others' concerns about use, social norms, the influence of partners, friends, and family, and social circle cannabis use. The substance use domain included early exposure to cannabis, initiation age and experiences, substance use disorder, preconception cannabis use, and tobacco co-use. The structural domain included cannabis-related stigma and discrimination, commercial influences, and the policy environment. The six domains, together, influenced prenatal cannabis use behaviors, including frequency of use, attempts to quit, and changes to use over the prenatal period.

Appendix B provides an overview of key IBM and LCT constructs used in this study, their definitions, how they are organized within the conceptual model, and whether they were measured qualitatively or quantitatively.

Figure 4. A Priori Conceptual Model: Multidimensional Influences on PCU



## Chapter 2. Influences on Cannabis Use Trends During Pregnancy: A Longitudinal Study of Low-Income Birthing People in Wisconsin

### Introduction

#### Background

Rates of prenatal cannabis use (PCU) have more than doubled in recent years, with an estimated eight percent of birthing people reporting use in 2022.<sup>1-3</sup> PCU prevalence rates are two to three times higher among birthing people who are younger, lower-income, have mental health conditions, and co-use tobacco.<sup>1-3,7</sup> Rates of PCU are thought to be underestimated, with multiple studies demonstrating discrepancies between self-report and biochemical verification, such as urine toxicology.<sup>9-11</sup>

Cannabis contains over 100 cannabinoids, and depending on the route of delivery, ingestion can introduce exposure to other compounds, including pesticides, solvents, inorganics, microbes, and mycotoxins.<sup>27,28</sup> Delta-9-tetrahydrocannabinol (THC), the most well-known of the cannabinoids, and metabolites pass through the placenta, affecting maternal, uterine, and placental blood flow.<sup>23,115,116</sup> Preclinical and human studies suggest that prenatal THC exposure dysregulates the fetal endocannabinoid system,<sup>24,117</sup> immune functioning,<sup>23</sup> and brain structure and functioning across several regions.<sup>23,38</sup> An increasing body of evidence is emerging, showing PCU to be independently associated with low birth weight,<sup>17,34,35</sup> small for gestational age,<sup>34,35</sup> preterm birth,<sup>34,35</sup> increased neonatal intensive care unit admissions,<sup>34</sup> and perinatal mortality.<sup>35</sup> Neuroimaging studies offer additional evidence of adverse physiological, neurodevelopmental, and psychological effects on exposed offspring.<sup>39,115</sup>

Leading public health and healthcare institutions such as the American College of Obstetricians and Gynecologists, American Academy of Pediatrics, American Society of Addiction Medicine, and the U.S. Surgeon General all advise pregnant people to abstain from cannabis,<sup>118,119</sup> however, efforts to address PCU have fallen short. According to the Substance Abuse and Mental Health Services Administration, there are no evidence-based programs for the prevention of prenatal cannabis use.<sup>120</sup>

Effective PCU prevention, intervention, monitoring, and policy efforts depend on accurately understanding PCU behaviors and the most salient factors influencing use. However, much of the older PCU literature is plagued with methodological issues. Most research doesn't take into account administration method or THC dosage, a particular concern given that the average THC potency in cannabis products has increased nearly four-fold over the past twenty-five years.<sup>121</sup> Additionally, much of the research literature measures PCU in a binary way (either they used or didn't use cannabis). However, according to the National Survey on Drug Use and Health (NSDUH), 16% of pregnant people used cannabis in their first trimester, while only four percent used cannabis in the second trimester and five percent in the third trimester.<sup>7</sup> Moreover, qualitative studies indicate that 60-70% of cannabis users report quitting during pregnancy, and approximately 30-40% continue to use throughout their pregnancies.<sup>12,62,83-90</sup> Thus, measuring PCU at a single time point and in a binary way does not reflect real-world use patterns and can lead to inaccurate and biased findings.<sup>122</sup>

To design effective interventions and supportive policies, it is also imperative to understand the most salient influences on PCU. For example, mental health conditions and tobacco co-use are strongly and consistently associated with higher rates of PCU<sup>12,123</sup> however,

it remains unclear the extent to which these factors influence cannabis use patterns, such as frequency and changes to cannabis use over the prenatal period.

### **Purpose**

The overall purpose of this study was to (1) examine overall cannabis use trends over the prenatal period and (2) examine whether these trends differ based on demographic, psychological, social, and substance use factors. The term “cannabis use trends” has two components: (1) prenatal cannabis use frequency (PCUF), measured by past 30-day cannabis use, and (2) changes over time, which involves repeated measures at the first, second, and third trimesters. When examining differences in PCU patterns, “higher risk” factors are compared with “lower risk” factors. Findings from existing PCU literature determined risk categories.

### **Research Questions**

#### ***Research Question 1***

Research question one is, “What is the overall trend of PCUF over the prenatal period?”

Research question one hypotheses are as follows:

1. There will be a downward trend in PCUF over the prenatal period.
2. The downward PCU trend will be non-linear due to a drop in cannabis use in the second trimester.

#### ***Research Question 2***

Research question two is, “Will PCUF trends differ based on demographic factors?”

Research question two hypotheses are as follows:

1. Birthing people with higher risk factors (younger, minority race, lower income, lower education, unemployed, single) will use cannabis at higher rates than birthing

- people who are older, white race, higher education, employed, and in committed relationships.
2. Birthing people with higher demographic risk factors will have a decreased likelihood of a downward PCU trend during pregnancy.

### ***Research Question 3***

Research question three is, “Will PCUF trends differ based on substance use variables?”

Research question three hypotheses are as follows:

1. Birthing people with greater substance use risk factors (earlier cannabis initiation, longer duration of cannabis use, more frequent preconception use, and higher levels of tobacco use) will use cannabis at higher rates than birthing people with lower risks (later initiation, shorter duration of use, less preconception use, and lower tobacco use).
2. Birthing people with higher substance use risks will have a decreased likelihood of a downward PCU trend during pregnancy.

### ***Research Question 4***

Research question four is, “Will PCUF trends differ based on psychological variables?”

Research question four hypotheses are as follows:

1. Birthing people with higher psychological risk factors (intention to continue using cannabis during pregnancy, diagnosed mental health condition, higher anxiety levels, and higher depression levels) will use cannabis at higher rates than birthing people with lower psychological risk factors (intend to quit, no mental health condition, lower anxiety levels, lower depression levels).

2. Birthing people with higher psychological risks will have a decreased likelihood of a downward PCU trend during pregnancy.

### **Research Question 5**

Research question five is, “Will PCUF trends differ based on social variables?” Research question five hypotheses are as follows:

1. Birthing people with higher social risk factors (lower levels of social support, more cannabis users in their social circles, and those who reside in households where cannabis use is allowed) will use cannabis at higher rates than birthing people with lower social risk factors (higher social support, fewer cannabis users in their social circle, and reside in households where cannabis is not allowed).
2. Birthing people with higher social risk factors will have a decreased likelihood of a downward PCU trend during pregnancy.

### **Methods**

#### **Setting**

This study used secondary data from *First Breath*, Wisconsin's free, community-based, perinatal substance use program. A detailed description of First Breath can be found at [www.providefirstbreath.org](http://www.providefirstbreath.org). Recruitment, consent, and data collection were conducted by program staff, called First Breath Health Educators (HEs), as part of standard program operations. HEs are highly trained professionals who provide one-to-one education and early intervention services to pregnant people using a harm reduction approach. The University IRB reviewed this study and deemed it exempt because it involved secondary data analysis of deidentified data.

## **Sampling and Recruitment**

The study examined secondary data from participants enrolled in First Breath between January 1, 2022, and December 31, 2023. To be eligible for the program, participants must have resided in Wisconsin, been pregnant, and reported substance use at enrollment. Data used in this study was restricted to participants who completed a baseline survey, reported cannabis use at the baseline survey, and completed at least one follow-up survey during pregnancy.

## **Data Collection**

This study used data from surveys administered by HEs at three time points: baseline (first trimester), four months prenatal (second trimester), and seven months prenatal (third trimester). Data were collected as part of standard program operations and within the safety of an established therapeutic relationship. Baseline surveys were conducted over the phone by HEs during the enrollment process. Data included demographic information, preconception cannabis use, past 30-day cannabis use, past 7-day tobacco use, social support level, stress level, social circle cannabis use, household cannabis rules, and quit intentions. Follow-up surveys were administered during virtual (video chat) coaching sessions. Data collected during these surveys included past 30-day cannabis use, past 7-day tobacco use, a depression screener, and an anxiety screener. HEs entered all survey responses into Alchemer, a secure and HIPAA-compliant online data management system using the participants' unique six-digit identification numbers. Data underwent monthly data discrepancy checks, and any issues were resolved within one week.

## **Measures**

### ***Outcome Variable***

The primary outcome variable in this study was past 30-day cannabis use frequency, measured using timeline follow-back (TLFB), a commonly used method for quantifying cannabis use.<sup>124</sup> The question reads, “Of the past thirty days, how many days did you use cannabis?” to which participants respond with the number of days they used cannabis, zero through 30. This question was asked at all three time points.

### ***Predictor Variables***

***Demographics.*** Demographic data were collected at baseline and included participants’ age, education level (less than high school, high school or GED, more than high school), employment status (employed, employed part-time, unemployed), relationship status (single or in a committed relationship), and household income. There were seven options for race and ethnicity; however, due to very low cell counts, participants’ race/ethnicity was dichotomized into (1) White or (2) Black, Indigenous, or Person of Color (BIPOC).

***Substance Use Measures.*** At the baseline survey, age at cannabis initiation and preconception cannabis use (daily/almost daily, weekly, less than weekly) were documented. A new variable, cannabis use duration, was created by subtracting participants’ cannabis initiation age from their current age. Tobacco use was a repeated measure collected at all three time points using seven-day point prevalence, a commonly used measure of tobacco abstinence in prenatal populations.<sup>108,109</sup> Participants were asked how much they’ve smoked in the past seven days, to which they responded: (1) did not smoke, (2) smoked some but not all days, (3) smoked one to five cigarettes per day (cpd), (4) smoked six to ten cpd, (5) smoked 11 to 20 cpd,

or (6) smoked 20 or more cpd. Due to low cell counts, responses were collapsed into three categories: “non-smokers,” (option one above), 2) “light/intermittent smokers” (options two and three above), and 3) regular smokers (options four through six above). Past 30-day use of electronic nicotine delivery systems (ENDS or e-cigarettes), cigarillos and cigars, and other tobacco products were also collected.

**Psychological Measures.** At the baseline survey, participants were asked which of the following described their prenatal cannabis use goals: (1) intend to quit for good, (2) intend to quit for the perinatal period, (3) intend to cut down for good, (4) intend to cut down quit for the perinatal period, (5) no intent to change, or (6) intend to increase use. Due to low cell counts, responses were collapsed into “intend to quit” (combining above options one and two), “intend to cut down” (options three and four), or “continue use” (options five and six).

At baseline, participants were asked to report if they have ever had a diagnosed mental health condition (yes/no). A depression screening, the Patient Health Questionnaire (PHQ-9)<sup>125</sup> was administered in the second and third trimesters. Responses included a score (0-27) and a validated severity ranking (minimal, mild, moderate/severe). An anxiety screening, the Generalized Anxiety Disorder Assessment (GAD-7),<sup>126</sup> was also administered at the second and third trimesters. Responses also included a score (0-21) and severity ranking (minimal, mild, moderate/severe). Only the severity rankings were used in this analysis to align with clinically significant cut-offs.

**Social Measures.** At baseline, participants were asked how many people in their social circle (close friends and family) used cannabis (none/few, some, or most/all). They were also

asked about cannabis smoking rules in the household (not allowed or allowed). Participants also ranked their perceived level of social support (low, medium, or high).

### **Other Covariates**

**Trimester.** To conduct the longitudinal analysis, a new variable, “trimester,” was created corresponding with the three data collection time points. The baseline survey was coded as trimester one, the four-month prenatal survey as trimester two, and the seven-month prenatal survey as trimester three.

**Intervention Dose.** HEs recorded the total minutes spent counseling the participant at the three prenatal time points. The total minutes from each time point were added to create a continuous measure called “intervention dose.”

### **Data Analysis**

To prepare for analysis, datasets from each time point were linked by ID and imported into SAS<sup>®</sup> Studio OnDemand for Academics, Copyright © 2023 SAS Institute Inc.<sup>127</sup> Data were then transformed from wide to long to sufficiently handle the four repeated measures, which included (1) past 30-day cannabis use, (2) past seven-day tobacco use, (3) anxiety level, and (4) depression level.

Generalized estimating equations - or GEE - was selected as the analytic method for the following reasons: (1) to properly handle non-normally distributed count data, (2) to handle multiple repeated measures, (3) to account for within-subject correlation, and (4) to examine time-interaction effects. GEE was developed by Liang and Zeger in 1988 to produce regression estimates when analyzing repeated measures with non-normal response variables.<sup>128</sup> GEE accounts for within-subject correlation, can be used with non-normal data distribution, allows

for time-interaction variables, and incorporates the interaction between predictors of interest and time.

Before the analysis could begin, several tasks were carried out to specify the GEE model properly. First, PCUF distribution was examined to determine the most appropriate link function. Given the data were not normally distributed and count data, a log-link function was selected. Next, four models were run to understand the distribution of PCUF better. Poisson, zero-inflated Poisson (ZIP), negative binomial, and zero-inflated negative binomial (ZINB) models were run, and Akaike Information Criterion (AIC) was used to compare the goodness of fit of various models. For example, when examining the association between household cannabis rules and PCUF, the AIC for Poisson was 3,132, ZIP was 1,977, NB was 1,216, and ZINB was 1,196. Negative binomial and zero-inflated negative binomial had lower AICs than Poisson and zero-inflated Poisson in all models, and while ZINB was slightly lower than negative binomial (around 20 points), differences were negligible. Given that the GEE procedure in SAS is better suited to handle negative binomial and can appropriately handle missing data, negative binomial distribution was selected.

Finally, Pearson's correlation coefficients were run to determine whether the correlational structure was identity, autoregressive, exchangeable, or unstructured. PCUF at trimester one was moderate to strongly correlated with PCUF at trimester two ( $R=0.65$ ,  $p<.0001$ ). Similarly, PCUF at trimester two was strongly correlated with PCUF at trimester three ( $R=0.87$ ,  $p<.0001$ ). PCUF at trimester one was also moderately correlated with PCUF at trimester three ( $R=0.58$ ,  $p<.0001$ ). Given these results, an exchangeable correlation structure was selected to fit the GEE model.

Several steps were also taken to determine the best way to handle missing data. First, missing data flags were created to assess the number and proportion of missingness. Multiple imputation using (1) multivariate normal distribution (MVN) and (2) fully conditional specification (FCS) approaches were attempted. While there were no issues with the imputation and analysis phases, the pooling phases could not be completed due to dataset characteristics. Weighted GEE was also attempted, calculating the predicted probability of missingness and applying weights based on the inverse of these probabilities. This procedure was terminated in SAS during the pooling phase due to the missingness pattern in the dataset. Thus, standard GEE was used to run the remaining analyses.

Descriptive statistics were used to calculate the mean number of cannabis use days by trimester, and GEE was used to test whether PCUF differed by trimester. A linear prediction plot was created to examine the overall PCUF trend by trimester. Unadjusted models were run to test hypotheses for research questions two through five to determine whether predictors of interest were significantly associated with PCUF. Results are reflected in incident rate ratios (IRR) along with 95% confidence intervals and p-values. Next, main effect multivariate models were run to examine these associations, adjusting for variables significantly associated with PCUF in unadjusted models. Results are reflected as adjusted incident rate ratios (aIRR) along with 95% confidence intervals and p-values. Finally, time-interaction effect multivariate models were run to examine the effect of the predictor and time. These models included all predictors significantly associated with PCUF in previous models, prenatal dose, trimester, and an interaction term (predictor\*time). When interaction terms were significant in these models,

linear prediction means plots were produced to examine group-level differences in PCUF trends.

## Results

### Descriptives

**Sample Characteristics.** The sample included 76 birthing people who reported cannabis use at baseline and completed at least one follow-up survey. Of the 76 individuals who completed the baseline survey, 56 individuals completed a survey at trimester two, and 52 individuals completed a survey at trimester three. Table 2 provides an overview of participant characteristics. Most measures were collected were in their first trimester (n=76). Measures collected when participants were in their second trimester (n=56) and third trimester (n=52) are noted below.

Most participants were Medicaid recipients (80%), and more than 60% reported household incomes of less than \$30,000 annually. Most were married or in a committed relationship (72%), about half had a high school diploma or less (58%), and 47% were unemployed. A little more than 40% of the sample identified as black, indigenous, or people of color (BIPOC). The mean age of cannabis initiation was 15 years old (standard deviation 2.88), and the average number of years of cannabis use was 12 years (standard deviation 6.35). More than 70% of participants reported daily cannabis use in the preconception period. In the first trimester, 84% of participants reported tobacco co-use. Tobacco use declined in subsequent trimesters, with 55% reporting tobacco use in the second trimester and 43% in the third.

When asked about their intent to change cannabis use during pregnancy, 43% of participants indicated they planned to quit, 33% intended to cut down, and 24% did not intend

to make a change. Sixty-seven percent of participants reported having a diagnosed mental health condition. Participants were screened for depression using the PHQ-9 and anxiety using the GAD-7 during the second and third trimesters. Between 27-37% of participants had mild depression and anxiety symptoms, and 17-20% had moderate to severe symptoms at each time point. Half of the participants reported that “most or all” the people in their social circle also used cannabis, and 64% allowed cannabis use in their homes. Participants reported “fairly high” (26%) or “extremely high” (34%) social support.

**Table 2.** Participant Characteristics

<b>Demographic Characteristics</b>	n <sup>a</sup>	%
<b>Race</b>		
Black, Indigenous, People of Color (BIPOC)	31	41.89
White	43	58.11
<b>Household income</b>		
Less than \$10,000	26	35.14
\$10,000 - \$29,999	23	31.08
\$30,000 or more	25	33.78
<b>Education level</b>		
Less than high school	12	16.00
High school or GED	32	42.67
More than high school	31	41.33
<b>Employment status</b>		
Not employed	35	46.67
Employed part-time	14	18.67
Employed full-time	26	34.67
<b>Relationship status</b>		
Single	21	28.00
Married or in a committed relationship	54	72.00
<b>Insurance</b>		
Medicaid	60	80.00
Other	15	20.00
<b>Age at baseline in years (mean (SD))</b>	26.24 (5.28)	
<b>Substance use</b>	n	%
<b>Preconception cannabis use</b>		
Less than weekly	9	12.16
Weekly	12	16.22
Daily	53	71.62
<b>Substance use disorder</b>		

No	50	67.57
Yes	24	32.43
Tobacco use (baseline)		
None	9	16.07
Light/intermittent (<5 cigarettes per day)	32	57.14
Regular (5 or more cigarettes per day)	15	26.79
Tobacco use (second trimester)		
None	25	45.45
Light/intermittent (<5 cigarettes per day)	21	38.18
Regular (5 or more cigarettes per day)	9	16.36
Tobacco use (third trimester)		
None	29	56.86
Light/intermittent (<5 cigarettes per day)	17	33.33
Regular (5 or more cigarettes per day)	5	9.80
Age at cannabis initiation in years (mean (SD))	14.61 (2.88)	
Years of cannabis use (mean (SD))	11.82 (6.35)	
Past 30-day cannabis use (mean (SD))		
First trimester	14.26 (12.57)	
Second trimester	10.50 (12.59)	
Third trimester	9.85 (12.59)	
<b>Psychological characteristics</b>	n	%
Intent to change during pregnancy		
Quit	32	42.67
Cut down	25	33.33
No change	18	24.00
Stress level		
High	27	36.49
Medium	32	43.24
Low	15	20.27
Mental health condition (diagnosed)		
No	25	33.33
Yes	50	66.67
Depression severity (2 <sup>nd</sup> trimester)		
Minimal	22	43.14
Mild	19	37.25
Moderate to severe	10	19.61
Anxiety severity (2 <sup>nd</sup> trimester)		
Minimal	29	51.79
Mild	17	30.36
Moderate to severe	10	17.86
Depression severity (3 <sup>rd</sup> trimester)		
Minimal	22	44.90
Mild	17	34.69
Moderate to severe	10	20.41

Anxiety severity (3 <sup>rd</sup> trimester)		
Minimal	29	55.77
Mild	14	26.92
Moderate to severe	9	17.31
<b>Social characteristics</b>	n	%
Cannabis users in social circle		
A few or none	20	27.03
Some	17	22.97
Most or all	37	50.00
Household cannabis use		
Not allowed	27	36.00
Allowed	48	64.00
Social support level		
Extremely high	25	33.78
Fairly high	19	25.68
Medium	18	24.32
Low	12	16.22
<b>Intervention Dose in Minutes (mean (SD))</b>	<b>54.33</b>	<b>38.04</b>

<sup>a</sup> Measures collected at baseline n=76, second trimester n=56, third trimester n=52; Numbers do not add up to n=76 due to missing data (<5 per measure)

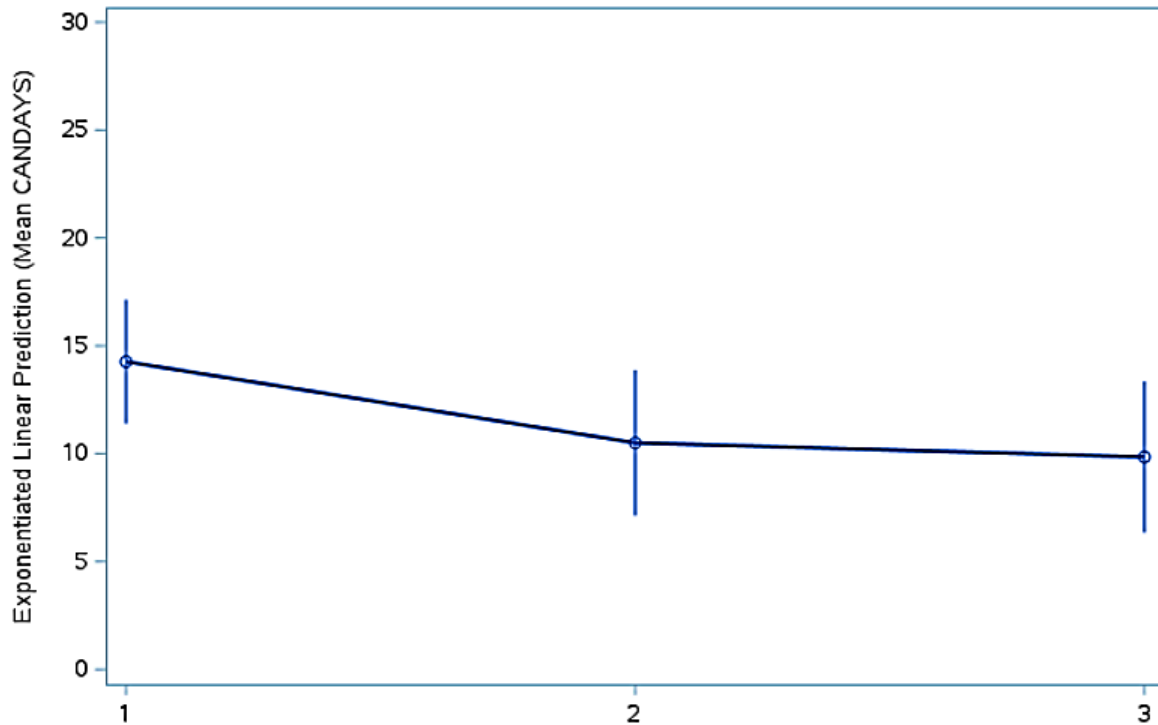
### **Research Question 1**

Research question one examined the overall trends in cannabis use frequency during pregnancy. Past 30-day cannabis use frequency was measured at three time points. In the first trimester, the mean number of past 30-day cannabis use was 14.26 days (standard deviation 12.58). In the second trimester, the mean number of cannabis use days declined to 10.5 days (standard deviation 12.59) and 9.84 days (standard deviation 12.59) during the third trimester. In unadjusted models, trimester predicted PCUF. Second-trimester PCUF was significantly lower than the first trimester (IRR 0.76, 95% CI 0.61-0.94, p=0.01). Similarly, third-trimester PCUF was significantly lower than the first trimester (IRR 0.69, 95% CI 0.51-0.88).

Figure 5 shows PCUF by trimester, indicating overall downward trends in prenatal cannabis use frequency. This downward trend was non-linear due to a drop in frequency in the

second trimester. Based on these findings, both hypotheses for the research question were accepted.

**Figure 5.** Mean Cannabis Use Frequency by Trimester, Past 30 Days



Abbreviation: 1, Trimester 1; 2, Trimester 2; 3, Trimester 3

Research questions two through five examined whether PCUF trends differed based on demographic, substance use, psychological, or social factors. Findings are briefly explained here to introduce the tables. Detailed explanations and interpretations by research question can be found starting on page 47.

Table 3 shows bivariate associations between predictors of interest and PCUF. Prenatal counseling minutes and trimester were also examined for associations with PCUF. The trimester variable was treated as a continuous variable, as the goal was to examine trends over the prenatal period, not trimester-specific effects. Trimester was associated with PCUF (IRR

0.81, 95% CI 0.71-0.94,  $p=0.004$ ), meaning that for every one-unit change in trimester, expected PCUF decreased by 19%. Intervention dose, measured by minutes of counseling, was also associated with PCUF; however, the association was small (IRR 0.99, 0.99-1.00,  $p=0.01$ ). Counseling dose was adjusted for in all multivariate models. Trimester was included in the time-interaction effect multivariate models. Preconception use, tobacco use, anxiety, quit intentions, social circle cannabis use, and household cannabis rules were significantly associated with PCUF and examined in multivariate models.

Table 4 shows results from the main effect multivariate models, and Table 5 shows results from the time-interaction effect models. Each table includes four models: one adjusting for substance use variables, one for psychological variables, one for social, and a full model that adjusts for all significant predictors. The interaction between predictors of interest and trimester was also examined. Variables in the interaction terms were treated as continuous variables. Two interaction terms were significant (preconception cannabis use and trimester and social circle use and trimester) and were further examined in Table 5.

**Table 3.** Bivariate Analysis of Factors Associated with Prenatal Cannabis Use Frequency

<b>Variables by domain</b>	<b>IRR<sup>a</sup></b>	<b>95% CI</b>	<b>p-value<sup>b</sup></b>
<b>Demographic variables</b>			
Age	1.01	0.97-1.06	0.75
Race			
White (reference)	1.00		
BIPOC	1.46	0.96-2.21	0.08
Income			
More than \$30,000 (reference)	1.00		
\$10,000 - \$29,000	1.42	0.85-2.36	0.18
Less than \$10,000	1.01	0.56-1.80	0.99
Education			
More than high school (reference)	1.00		
High school or GED	1.63	0.96-2.76	0.07
Less than high school	1.26	0.77-2.06	0.37
Employment			
Employed full-time (reference)	1.00		
Employed part-time	1.21	0.78-1.90	0.39
Unemployed	0.86	0.42-1.75	0.68
Relationship status			
Married/committed (reference)	1.00		
Single	0.87	0.52-1.46	0.60
<b>Substance use variables</b>			
Cannabis initiation (age)	1.01	0.94-1.09	0.72
Cannabis duration (years)	0.99	0.96-1.03	0.74
Substance use disorder			
No (reference)	1.00		
Yes	1.26	0.83-1.93	0.28
Preconception cannabis frequency			
Less than weekly (ref)	1.00		
Weekly	1.97	0.67-5.77	0.22
Daily	8.44	<b>4.31-16.54</b>	<b>&lt;.0001</b>
Tobacco quantity			
None	1.00		
Light/intermittent	2.44	<b>1.44-4.14</b>	<b>0.0009</b>
Regular	2.81	<b>1.63-4.82</b>	<b>0.0002</b>
<b>Psychological variables</b>			
Mental health condition			
No (ref)	1.00		
Yes	0.99	0.65-1.15	0.97
Anxiety Severity (GAD-7)			
Minimal	1.00		
Mild	1.02	0.68-1.52	0.93
Moderate/Severe	<b>0.45</b>	<b>0.28-0.70</b>	<b>0.0005</b>

Depression Severity (PHQ-9)			
Minimal	1.00		
Mild	0.85	0.50-1.44	0.54
Moderate/Severe	1.10	0.75-1.62	0.62
Intent to quit			
Quit	1.00		
Cut down	<b>1.87</b>	<b>1.19-2.95</b>	<b>0.006</b>
No change	1.34	0.74-2.44	0.34
<b>Social variables</b>			
Social support			
Extremely high	1.00		
Fairly high	1.31	0.65-2.66	0.45
Medium	1.19	0.58-2.41	0.64
Low	1.34	0.67-2.68	0.40
Social circle cannabis users			
Few/None	1.00		
Some	<b>2.24</b>	<b>1.10-4.54</b>	<b>0.03</b>
Most/All	<b>2.38</b>	<b>1.20-4.54</b>	<b>0.008</b>
Household cannabis rules			
Not allowed (reference)	1.00		
Allowed	<b>2.01</b>	<b>1.25-3.26</b>	<b>0.004</b>
<b>Other</b>			
Trimester	<b>0.81</b>	<b>0.71-0.94</b>	<b>0.004</b>
Minutes of counseling	<b>0.99</b>	<b>0.99-1.00</b>	<b>0.01</b>

<sup>a</sup> Incident rate ratio, <sup>b</sup> Bold p-values denote significance at the 0.05 level

**Table 4.** Main Effect Multivariate Associations with Prenatal Cannabis Use Frequency

Predictor	Model 1 (Associations with substance use variables) <sup>a</sup>			Model 2 (Associations with psychological variables) <sup>b</sup>			Model 3 (Associations with social variables) <sup>c</sup>			Model 4 (Full model) <sup>d</sup>		
	aIRR <sup>e</sup>	95% CI	p-value <sup>f</sup>	aIRR	95% CI	p-value	aIRR	95% CI	p-value	aIRR	95% CI	p-value
<b>Substance use variables</b>												
Preconception cannabis use												
Less than weekly (ref)	1.00									1.00		
Weekly	1.82	0.57-5.85	0.31							1.27	0.31-5.23	0.73
Daily	<b>9.98</b>	<b>5.15-19.36</b>	<b>&lt;.0001</b>							<b>7.18</b>	<b>2.62-19.68</b>	<b>0.0001</b>
Tobacco use												
None (ref)	1.00									1.00		
Light or intermittent	<b>2.74</b>	<b>1.49-5.04</b>	<b>0.001</b>							<b>2.42</b>	<b>1.40-4.18</b>	<b>0.0016</b>
Regular	<b>3.27</b>	<b>1.78-6.00</b>	<b>0.0001</b>							<b>2.75</b>	<b>1.51-5.03</b>	<b>0.0010</b>
<b>Psychological variables</b>												
Prenatal cannabis use goals												
Quit (ref)				1.00						1.00		
Cut down				2.29	1.34-3.91	0.002				0.99	0.52-1.88	0.97
No change				1.58	0.83-3.02	0.17				0.89	0.46-1.72	0.74
Anxiety severity												
Minimal (ref)				1.00						1.00		
Mild				1.21	0.76-1.91	0.42				1.17	0.67-2.04	0.60
Moderate/severe				<b>0.45</b>	<b>0.29-0.69</b>	<b>0.0002</b>				0.58	0.26-1.28	0.18
<b>Social variables</b>												
Cannabis use social circle												
None (ref)							1.00			1.00		
Some							1.85	0.93-3.69	0.08	1.75	0.68-4.52	0.25
Most/All							1.85	0.90-3.80	0.09	<b>2.54</b>	<b>0.98-6.59</b>	<b>0.05</b>
Cannabis allowed in home												
No (ref)							1.00			1.00		
Yes							<b>1.95</b>	<b>1.11-3.43</b>	<b>0.02</b>	<b>2.12</b>	<b>1.11-4.05</b>	<b>0.02</b>
<b>Intervention dose</b>	<b>0.99</b>	<b>0.99-1.00</b>	<b>0.004</b>	1.00	0.99-1.00	0.31	1.00	0.99-1.00	1.49	1.00	0.99-1.00	0.14

<sup>a</sup> Substance use variables: Preconception cannabis frequency, prenatal tobacco frequency, <sup>b</sup> Psychological variables: Intent to quit, anxiety severity, <sup>c</sup> Social variables: Household cannabis rules and cannabis use in social circle, <sup>d</sup> Full model includes substance use variables, psychological variables, social variables and intervention dose, <sup>e</sup> Incident rate ratio, <sup>f</sup> Bold p-values denote significance at the 0.05 level

**Table 5.** Time-Interaction Effect Multivariate Associations with Prenatal Cannabis Use Frequency

Predictor	Model 1 (Associations with substance use variables) <sup>a</sup>			Model 2 (Associations with psychological variables) <sup>b</sup>			Model 3 (Associations with social variables) <sup>c</sup>			Model 4 (Full model) <sup>d</sup>		
	aIRR <sup>e</sup>	95% CI	p-value	aIRR	95% CI	p-value	aIRR	95% CI	p-value	aIRR	95% CI	p-value
<b>Substance use variables</b>												
Preconception cannabis use (PCCU)												
Less than weekly (ref)	1.00									1.00		
Weekly	2.02	0.71-5.77	0.18							1.21	0.17-8.62	0.85
Daily	<b>10.98</b>	<b>6.03-19.99</b>	<b>&lt;.0001</b>							<b>8.30</b>	<b>2.89-23.84</b>	<b>&lt;.0001</b>
Tobacco use												
None (ref)	1.00									1.00		
Light or intermittent	<b>2.72</b>	<b>1.47-5.04</b>	<b>0.001</b>							<b>2.03</b>	<b>1.19-3.47</b>	<b>0.0009</b>
Regular	<b>3.01</b>	<b>1.64-5.53</b>	<b>0.0004</b>							<b>2.95</b>	<b>1.36-6.39</b>	<b>0.006</b>
Trimester	0.91	0.77-1.08	0.31							0.86	0.71-1.05	0.14
Intervention Dose	1.00	0.99-1.00	0.11							1.00	1.00-1.00	0.96
PCCU*Trimester	<b>3.56</b>	<b>2.40-5.30</b>	<b>&lt;.0001</b>							<b>1.69</b>	<b>1.40-2.05</b>	<b>&lt;.0001</b>
<b>Psychological variables</b>												
Prenatal cannabis use goals												
Quit (ref)				1.00						1.00		
Cut down				0.51	0.05-5.31	0.57				1.05	0.55-2.01	0.87
No change				0.16	0.03-7.37	0.34				0.92	0.47-1.78	0.81
Anxiety severity												
Minimal (ref)				1.00						1.00		
Mild				0.88	0.73-1.05	1.15				1.08	0.63-1.87	0.78
Moderate/severe				<b>0.19</b>	<b>0.15-0.25</b>	<b>&lt;.0001</b>				0.53	0.24-1.16	0.11
Trimester				0.85	0.69-1.06	0.15						
Intervention Dose				1.00	1.00-1.01	0.80						
<b>Social variables</b>												
Social circle cannabis use												
None (ref)							1.00			1.00		
Some							<b>2.02</b>	<b>0.99-4.14</b>	<b>0.05</b>	<b>2.08</b>	<b>1.04-4.18</b>	<b>0.04</b>
Most/All							<b>2.11</b>	<b>1.02-4.38</b>	<b>0.04</b>	1.88	0.95-3.74	0.07
Cannabis allowed in home												
No (ref)							1.00			1.00		
Yes							<b>2.25</b>	<b>1.12-4.51</b>	<b>0.03</b>	<b>2.25</b>	<b>1.32-4.86</b>	<b>0.005</b>
Trimester							0.49	0.22-1.07	0.08			
Intervention Dose							1.00	0.99-1.00	0.49			
Social circle use *Trimester							<b>1.46</b>	<b>1.05-2.01</b>	<b>0.02</b>	1.10	0.75-1.59	0.62

<sup>a</sup> Substance use variables: Preconception cannabis frequency, prenatal tobacco frequency, trimester, dose, and interaction term <sup>b</sup> Psychological variables: Intent to quit, anxiety severity, trimester, and dose <sup>c</sup> Social variables: Household cannabis rules, cannabis use in social circle, trimester, dose, and interaction term <sup>d</sup> Full model includes substance use variables, psychological variables, social variables, trimester, intervention dose, and interaction terms, <sup>e</sup> Adjusted incident rate ratio

## **Research Question 2**

Research question two examined whether PCUF trends differed based on demographic factors. Table 3 shows that none of the six demographic characteristics—age, race, income, education, employment, and relationship status—were associated with PCUF in unadjusted models. Both hypotheses for research question two were rejected. Because none of these variables were associated with PCUF they were not included in multivariate models.

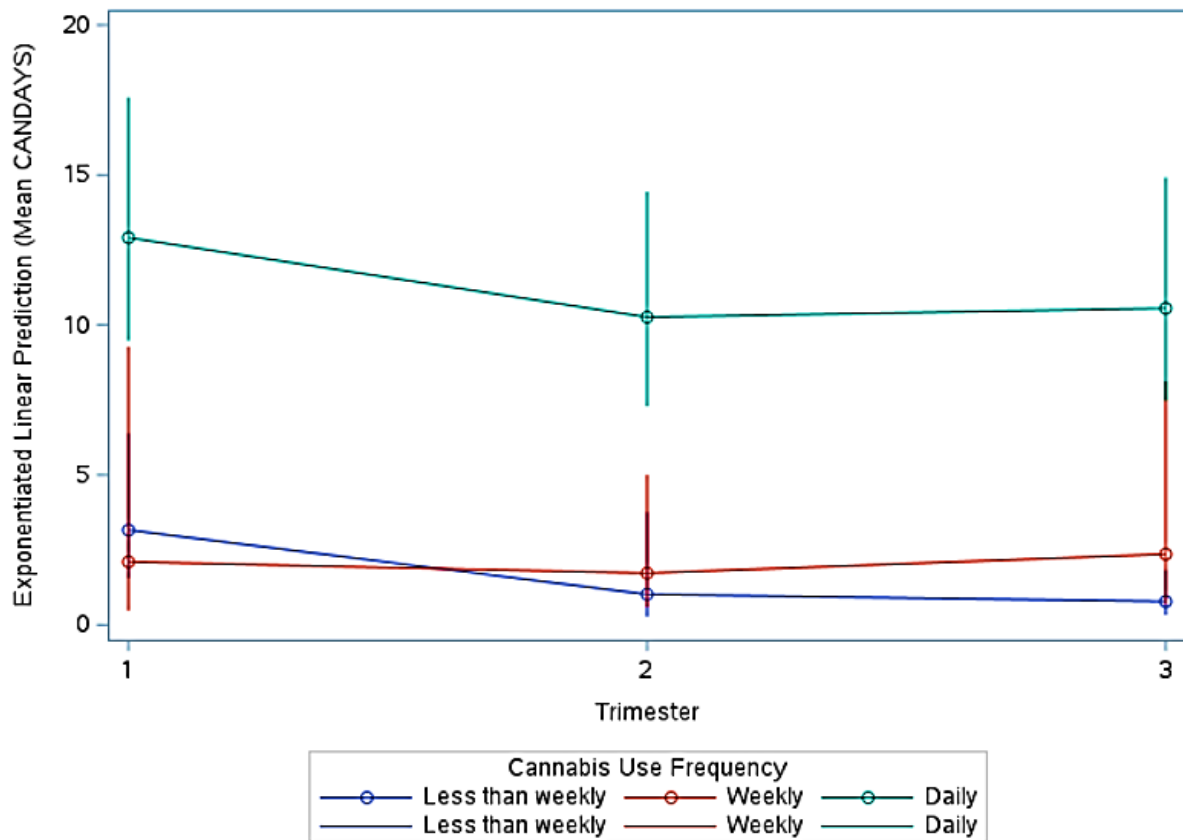
## **Research Question 3**

Research question three examined whether PCUF trends differ based on substance use variables: cannabis use initiation, duration, preconception use, and tobacco co-use. As shown in Table 3, neither cannabis initiation nor duration was associated with PCUF. However, participants who reported daily cannabis use during preconception used cannabis during pregnancy at more than five times the rate of those who reported less than weekly preconception use. Table 4 shows that this relationship remained significant after adjusting for other substance use variables and in the fully adjusted main effect model (aIRR 7.18, 95% CI 2.62-19.68,  $p=.0001$ ).

Table 5 shows that this relationship remained significant in the fully adjusted, time-interaction model (aIRR 8.30, 95% CI 2.89-23.84,  $p<0.001$ ). The interaction between preconception cannabis use frequency and PCUF was also significant in both unadjusted models and time-interaction models ( $p<.0001$ ), meaning the effect of preconception cannabis use on PCUF varied across different trimesters. Figure 6 shows the predictive margins of PCUF by trimester and preconception cannabis frequency in the fully adjusted models. Daily and weekly users were less likely to have a downward trend in PCUF compared with less than weekly users.

For example, daily preconception users' PCUF dropped from trimester one to two, then increased slightly in trimester three. Weekly preconception users exhibited a slight upward trend across all three trimesters.

**Figure 6.** Predictive margins of PCUF by trimester and preconception cannabis frequency



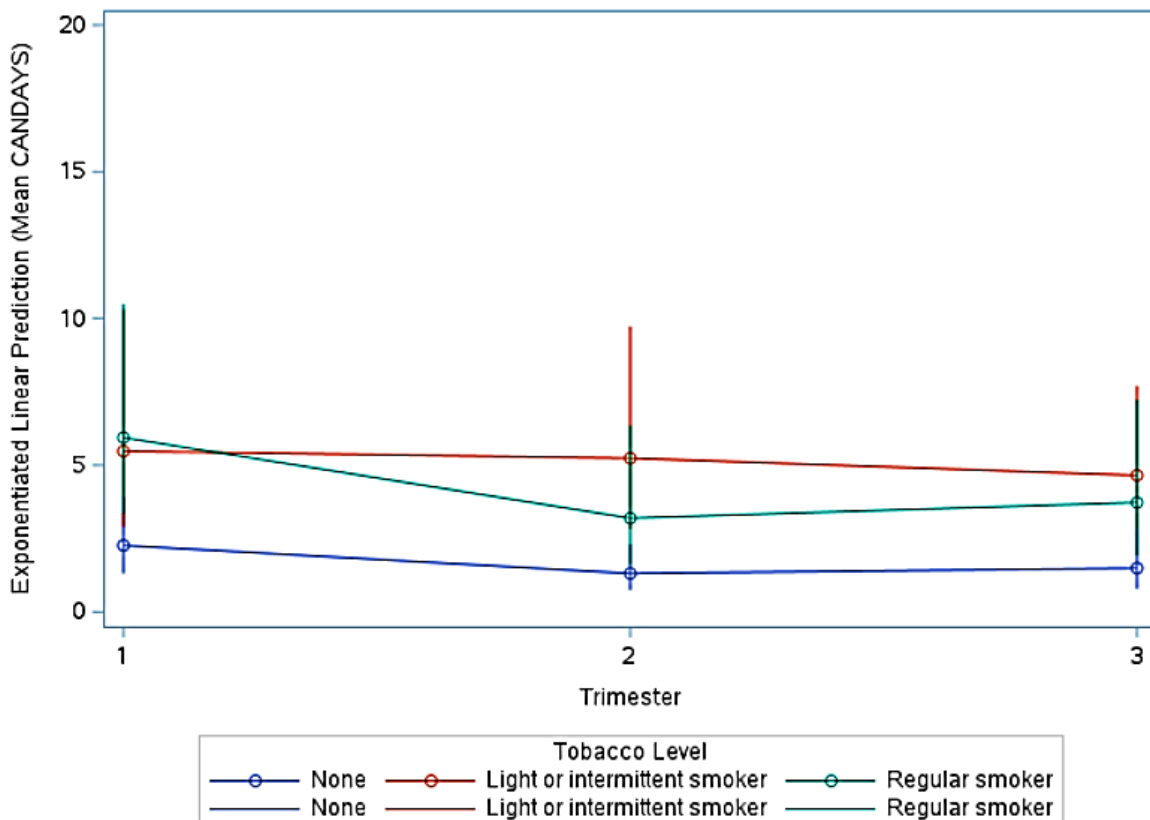
Tobacco use was also associated with PCUF. As shown in the unadjusted models (Table 3), pregnant people who were light/intermittent and regular tobacco users used cannabis at more than double the rate of people who used no tobacco. This relationship remained significant in fully adjusted main effect models (Table 4).

In the fully adjusted, time-interaction models (Table 5), light/intermittent smokers used cannabis at more than double the rate of non-smokers (aIRR 2.03, 95% CI 1.19-3.47, p=0.009).

Similarly, in fully adjusted, time-interaction model, regular smokers used cannabis at nearly

three times the rate of non-smokers (aIRR 2.95, 95% CI 1.36-6.39, p=0.006). Figure 7 shows the predictive margins of PCUF by trimester and tobacco level in the fully adjusted models. Regular and light/intermittent smokers were less likely to have a downward trend in CUF than non-smokers. Regular smokers had a downward trend in PCUF between trimesters one and two and a slight uptick between trimesters two and three. Light/intermittent smokers' cannabis use remained consistent across the prenatal period.

**Figure 7.** Predictive Margins of PCUF by Trimester and Tobacco Level



Research question three, hypothesis one, “birthing people with higher risk substance use risk factors will have higher rates of PCUF compared with birthing people with lower risk factors,” was rejected for cannabis initiation and duration but accepted for preconception use and tobacco level. Hypothesis two, “birthing people with higher substance use risk factors will

have a decreased likelihood of a downward PCU trend during pregnancy,” was also accepted for cannabis initiation and duration but accepted for preconception use and tobacco level.

#### **Research Question 4**

Research question four examined whether PCUF trends would differ based on the following psychological variables: intention to continue using cannabis, having a mental health condition, higher depression, and higher anxiety. There were no differences in PCUF rates when comparing birthing people who intended to quit compared with those who intended to continue using cannabis during pregnancy. In unadjusted models, participants who said they intended to cut down reported higher rates of cannabis use than those who intended to quit (IRR 1.87, 95% CI 1.19-2.95,  $p=0.0006$ ); however, this relationship did not persist in any of the adjusted models.

Having a mental health condition alone was not associated with PCUF in any of the models, nor was depression level. Interestingly, in the main effect model that adjusted for other psychological variables, participants who reported moderate to severe anxiety used cannabis at *lower* rates than those who reported minimal anxiety (aIRR 0.45, 0.29-0.69,  $p=0.0002$ ). Similarly, in the time-interaction model adjusting for psychological variables, participants who reported moderate to severe anxiety used cannabis at a lower rate than those who reported minimal anxiety (aIRR 0.19, 0.15-0.25,  $p<.0001$ ). These relationships did not persist in the fully adjusted main effect or time-interaction models. Based on these findings, hypotheses for research question four were rejected across all psychological variables.

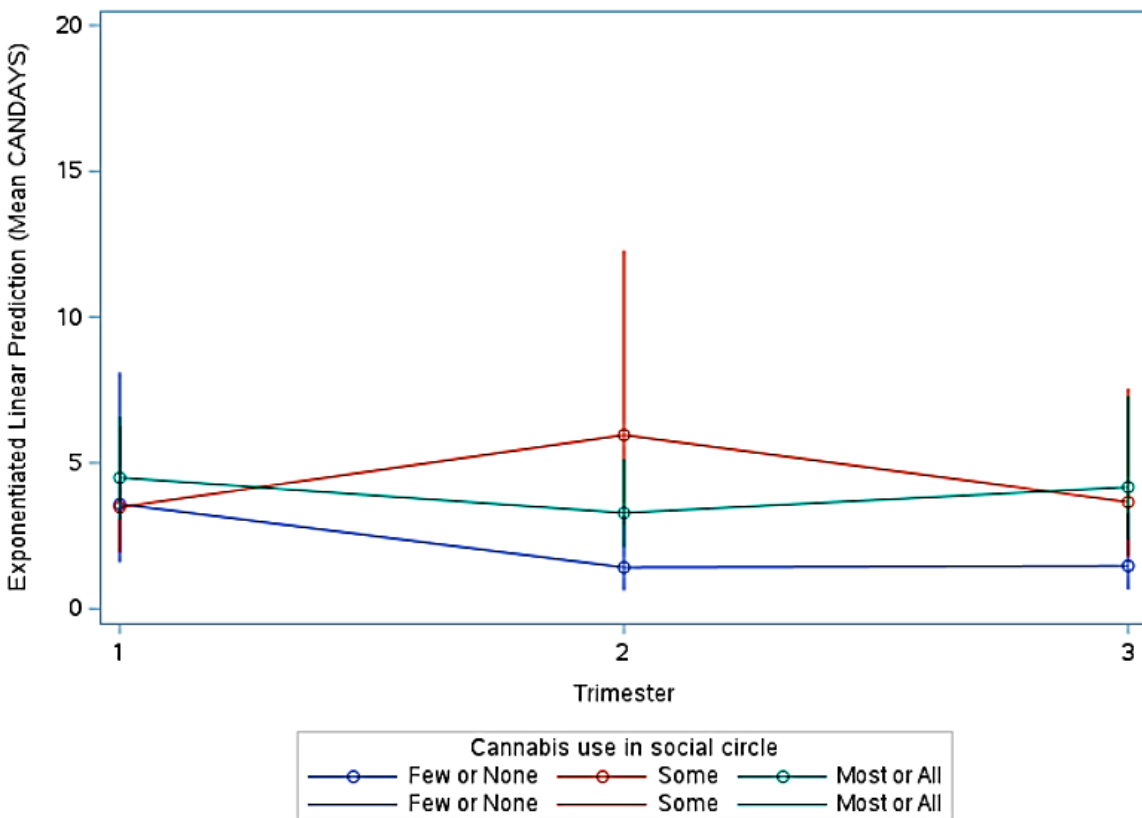
### **Research Question 5**

Research question five examined whether PCUF trends would differ based on social variables, including social support, social circle cannabis use, and household cannabis rules. Social support level was not associated with PCUF in any of the models, however, social circle cannabis use was. In unadjusted models, birthing people who reported that some of the people in their social network used cannabis used cannabis themselves at more than twice the rate as those who reported few or no cannabis users in their social network. This relationship remained significant in a main effect, fully adjusted model (Table 4) and the time-interaction model (Table 5) that adjusted for other social variables (aIRR 2.11, 95% CI 1.02-4.38,  $p=0.04$ ). A similar relationship was revealed when comparing people who said “most or all” of the people in their social circle were cannabis users compared with those who reported “few or none.” This relationship remained significant in both time-interaction adjusted models (aIRR 2.08, 95% CI 1.04-4.18,  $p=0.04$ ).

The interaction between social circle cannabis use and PCUF was significant in the unadjusted model and the time-interaction models that controlled for other social variables. This means the effect of social circle cannabis use on PCUF varied across different trimesters, even when accounting for other social influences. The interaction was no longer significant in the full, time-interaction model, which accounted for other substance use and mental health factors. Figure 8 shows the predictive margins of PCUF by trimester and social circle cannabis use. Birthing people who said “most or all” or “some” of the people in their social circle used cannabis were less likely to have a downward trend in PCUF compared with those who said “none.” PCUF among birthing people who said “most or all” of the people in their social circle

used cannabis decreased slightly from the first to the second trimester, then increased somewhat during the third trimester. This pattern was the opposite among birthing people who indicated that “some of the people in their social circle used cannabis.” PCUF among birthing people who said “few or none of the people in their social circle used cannabis” decreased from trimester one to trimester two and remained steady from trimester two to three.

**Figure 8.** Predictive Margins of PCUF by Trimester and Social Circle Cannabis Use

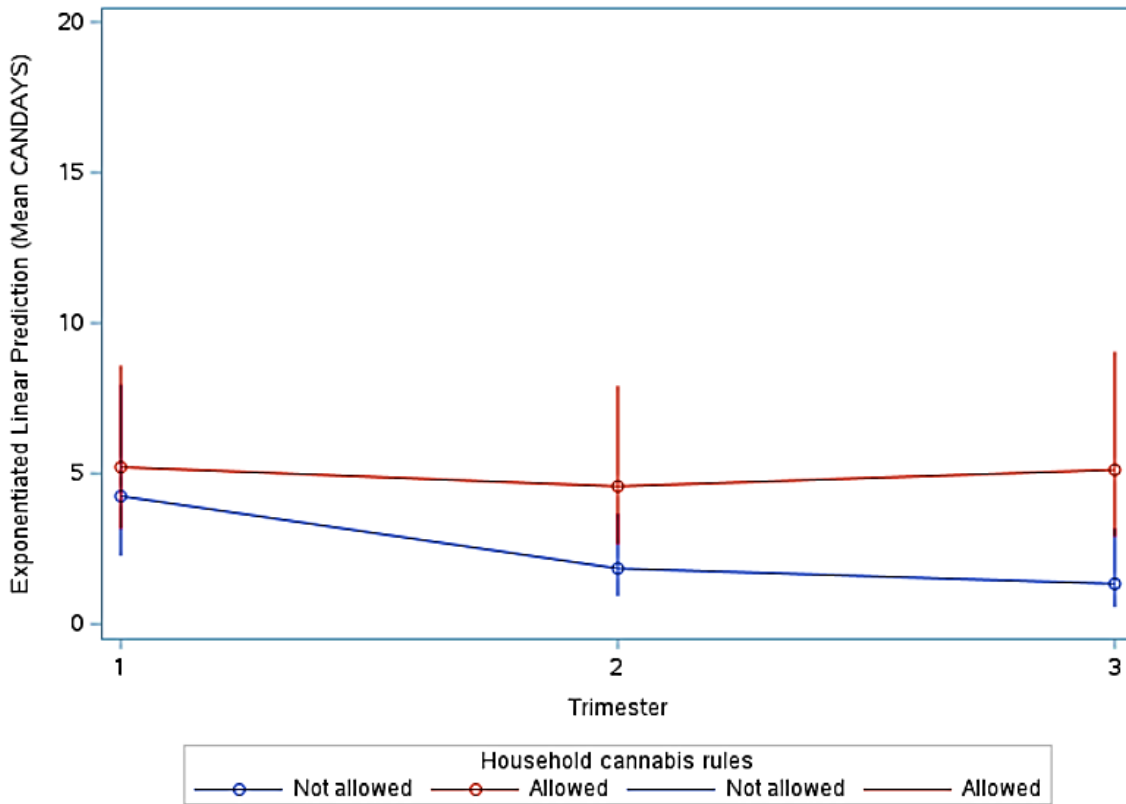


Household cannabis rules were also associated with PCUF. In unadjusted models, pregnant people who lived in households where cannabis was allowed used cannabis at nearly two and a half times the rate as those who reported that cannabis was non-allowed. This relationship remained significant in all the adjusted models. For example, in a time-interaction, full model, participants who resided in homes where cannabis was allowed used cannabis at

a 2.25 higher rate than those who lived in households where cannabis was not allowed (aIRR 2.25, 95% CI 1.32-4.86, p=0.005).

While the interaction between household cannabis rules and PCUF was not statistically significant in the bivariate analysis, patterns were examined, given the significance of household cannabis rules in time-interaction models. Figure 9 shows the predictive margins of PCUF by trimester and household cannabis rules. Birthing people who lived in households where cannabis was not allowed had a downward trend in PCUF across all three trimesters. A non-linear trend was noted, with a greater decrease at trimester two. Birthing people who lived in households where cannabis was allowed had little to no change in PCUF across trimesters.

**Figure 9.** Predictive Margins of PCUF by Trimester and Household Cannabis Rules



Research question five, hypothesis one, “birthing people with higher social risk factors” will have higher rates of PCUF compared with birthing people with lower risk factors,” was rejected for social support but accepted for social circle cannabis use and household cannabis rules. Similarly, hypothesis two, “birthing people with higher social risk factors will have a decreased likelihood of a downward PCU trend during pregnancy” was rejected for social support but accepted for social circle cannabis use and household cannabis rules.

## **Discussion**

This study used GEE to (1) examine overall PCU trends (frequency and changes) over the prenatal period and (2) examine whether these trends differ based on demographic, psychological, social, and substance use factors. Several key factors, preconception cannabis use, tobacco co-use, social circle cannabis use, and household cannabis rules, emerged as key influences on PCUF. Group-level differences in PCU trends over the prenatal period were identified.

## **Overall Trends**

Overall, birthing people in this study showed a downward trend in PCUF over the prenatal period, with a drop in the second trimester. The amount of cannabis used during the second and third trimesters was significantly lower than the first trimester. This aligns with PCU trimester prevalence estimates, drawing from population-level surveillance data such as NSDUH. This also makes sense in the context of common pregnancy experiences. Birthing people report using cannabis to manage pregnancy-related symptoms that are more common during the first trimester, like nausea, vomiting, and loss of appetite.<sup>129,130</sup> By the second trimester, these symptoms may have started to subside, and therefore, cannabis use rates

drop. The timing of pregnancy confirmation could also be a factor when examining changes in PCUF. Birthing people may be using more cannabis in the first few weeks of gestation, then reduce use upon pregnancy discovery or confirmation. These findings affirm the importance of measuring PCU at multiple time points across the prenatal period.

### **Demographic Factors**

None of the demographic factors examined in this study were associated with PCUF. The sample was relatively homogeneous in terms of socioeconomic status, as most people in this study had household incomes of less than \$30,000 per year, which could have explained the lack of findings in this area. While race was examined, it was not a focus of this study for multiple reasons. BIPOC communities have been systematically targeted and harmed by cannabis criminalization in the U.S.<sup>67</sup> leading to racist beliefs and stigmatizing practices. Studies that used PRAMS data tend to indicate lower PCU rates among non-Hispanic Black (NHB),<sup>2,12,47</sup> while studies that used NSDUH data indicated a *higher* PCU prevalence among NHB people compared with other races.<sup>48,53</sup> These discrepancies are likely a result of bias in measurement, testing, and disclosure. For example, a large study of hospital discharge data found that NHB pregnant people were tested at twice the rate of non-Hispanic Whites (NHW).<sup>51</sup> A retrospective cohort study also found that while NHB pregnant people were more likely to self-report use than NHWs, they were not more likely to have screened positive.<sup>131</sup> Future research should go beyond the association between race and PCU and focus on more influential and important constructs such as experiences of racism, stigma, and acculturation.

## **Substance Use Factors**

In examining substance use factors, neither cannabis initiation nor years of use were associated with PCUF. Preconception use frequency, however, was a significant predictor of cannabis use throughout the prenatal period. In a fully adjusted model that accounted for other variables and time, preconception daily users used cannabis at nearly nine times the rate during pregnancy compared with less than weekly preconception users. Examining trends over the prenatal period revealed additional complexities. Birthing people who were daily preconception users experienced a decreased PCUF between trimesters one and two but then an increase at trimester three. In this analysis, weekly preconception users, considered “medium risk” in this analysis, " exhibited a clear upward PCUF trend over the prenatal period. These findings point to the need for interventions that occur before pregnancy and are sustained throughout pregnancy. This approach is further supported by recent recommendations to treat preconception cannabis use as an essential public health issue.<sup>123</sup>

Birthing people who were light/intermittent and regular tobacco users used cannabis at more than double the rate of people who used no tobacco. These relationships remained significant in models adjusting for other substance use factors and in the fully adjusted, time-interaction models. Birthing people who were “regular” tobacco users saw a decreased PCUF between trimesters one and two but then an increase at trimester three. Concerningly, birthing people who were “light/intermittent” tobacco users had a slight increase in PCUF trends over the prenatal period. Cannabis-tobacco co-use (CTCU) is associated with a range of adverse birth, infant, and maternal health outcomes.<sup>64</sup> Research shows that CTCU increases risk over

either substance alone, suggesting a synergistic effect. Thus, identifying appropriate CTCU screening and evidence-based interventions is a top priority.

### **Psychological Factors**

There were mixed results when examining the relationship between mental health and PCUF. More than 60% of participants reported having a mental health condition, yet having a condition alone was not associated with the amount of cannabis used. In some models, moderate-to-severe anxiety was associated with higher rates of PCU compared with those who reported mild anxiety. Surprisingly, in other models, participants who reported moderate/severe anxiety used cannabis at *lower* rates than those with minimal anxiety. It is possible that the relative homogeneity of this population (60% had a mental health condition, and most were low-income) influenced the results. While psychological factors were not the most salient influences on PCUF in this study, they should not be ruled out, given the significance of mental health in other PCU research.<sup>132</sup> The mixed findings on the role of anxiety warrant further investigation. It is possible that those with more severe anxiety were either engaged in mental health care or were modulating their use based on their symptoms. Future research, qualitative and mixed methods, is needed to understand these results better.

Behavioral intent was not associated with PCUF. Several health behavior theories and models, like the Integrated Behavior Model, posit that behavioral intent is the most important influence on behavior.<sup>112</sup> However, that assumption did not hold in this study, aligning with other evidence suggesting that the intention-behavior relationship is weaker than previously thought. For example, one conceptual and empirical review of intention-behavior relations found that intentions only explained about 28% of the variance in behavior.<sup>133</sup> Another meta-

analysis of experimental tests of intention-behavior found that intentions only led to small-to-medium behavioral changes.<sup>134</sup> A more in-depth examination of behavioral constructs and PCUF is warranted. For example, a study found that self-efficacy was a critical driver of both cessation and continued use of substances during pregnancy.<sup>135</sup>

### **Social Factors**

Social factors were highly influential on PCUF. Birthing people who reported that most or all the people in their social circle (1) used cannabis themselves at significantly higher rates than those with fewer cannabis users in their social circle, (2) were less likely to have a downward trend in PCUF over the prenatal period. Additionally, those who resided in households where cannabis was allowed (1) used cannabis at significantly higher rates than people who resided in households where cannabis was not allowed and (2) exhibited a slight upward trend in PCUF over the prenatal period.

While social influences on cannabis use have been studied in adolescents and non-pregnant adults, few studies examine its role in PCU. Most PCU literature only examines the association between relationship status and PCU, which doesn't tell us the full picture. The findings of this study affirm the important role of social influences on PCU rates and changes over the prenatal period. Further research on the influence of other, more expansive social influences on PCU and the efficacy of family-based interventions should be examined.

### **Public Health Implications**

Findings from this study demonstrate the complexity of cannabis use patterns during pregnancy. Frequency of use and changes over the prenatal period were important considerations when determining the most salient influences on PCU. Unfortunately, most of

the PCU literature uses “ever used” or “ever exposed,” which does not reflect the reality of PCU patterns demonstrated in this study. This oversimplification of PCU can severely limit the understanding of prevalence, trends, and the ability to estimate the effects of PCU on maternal and infant health outcomes.

Perinatal research must use measures that account for the dynamic changes during pregnancy. The way PCU was measured in this study (PCU frequency at multiple time points) is an improvement over “ever-used” measurements typically used; however, it does not tell the complete picture, particularly if the goal is to examine risk profiles or dose-response effects. Future public health efforts and research should consider differences in administration methods (edibles, vaping, smoking), cannabinoid dose and ratios, and other use patterns. Standard measures of cannabis that can be used across administration methods have been suggested.<sup>136</sup>

Research should also focus on birthing people who use cannabinoid hemp products (CHP), which are currently under-regulated. There has been an explosion in the production and availability of these products, due to regulatory gaps in the 2018 Farm Bill, which excluded cannabis derivatives. A qualitative analysis of available cannabis-derived products, for instance, identified 111 distinct cannabinoids across 84 product types.<sup>81</sup> These products are not subject to quality and safety guidelines, and the potential health effects during pregnancy are largely unknown, raising significant safety concerns.<sup>82</sup>

A similar story can be told about mental health changes during pregnancy. Like PCU measurement, this study used repeated measures of depression and anxiety severity. While an improvement over binary measures of perinatal mental health (e.g., a birthing person has or

does not have depression), it did not capture other mental and behavioral conditions, nor the perceived burden of these conditions. Using measures that capture both severity and changes over the prenatal period is warranted.

Beyond improvement measurement strategies, findings from this study can be used to inform public health prevention, intervention, and policy efforts. Overall, preconception use, tobacco co-use, and social factors were the strongest predictors of PCUF and remained significant after adjusting for time. While birthing people who had higher risk factors like higher preconception use and tobacco co-use had higher rates of PCUF, concerning patterns were also seen among those with lower-risk characteristics. For example, birthing people who identified as weekly preconception users exhibited a clear upward PCUF trend, and birthing people who were light/intermittent tobacco users had a slight increase in PCUF trend over the prenatal period.

Taken together, these findings support the need for tailored, birthing person-centered PCU interventions that incorporate mental health, social influences, and tobacco co-use. Theoretical frameworks should be used to develop and test interventions. While behavioral intention, a fundamental construct from the Integrated Behavior Model<sup>112</sup> did not hold up in this study, critical constructs from Lifecourse theory (LCT), such as preconception use and social influences, were supported.<sup>114</sup> LCT has been recommended as an approach to address cannabis use during pregnancy and maternal and child health issues more broadly.<sup>110</sup>

Social, commercial, and political determinants of health are important considerations when planning strategies to address PCU. For fifty years, cannabis was federally classified as a Schedule I substance under the Controlled Substances Act. This was the precursor to the so-

called “War on Drugs,” a series of criminalizing laws, enforcement-based approaches, drug-related arrests, and incarceration that disproportionately targeted Black people. Additionally, substance use during pregnancy is considered grounds for child abuse and civil commitment in many states, even though punitive policies around substance use during pregnancy are linked with worse perinatal outcomes.<sup>137</sup> To protect MCH populations, states should remove substance use as grounds for child abuse and/or civil commitment, remove reporting requirements for substance use, and prohibit discrimination against pregnant people who use substances in their state statutes.

### **Limitations and Strengths**

This study had a small sample size, limiting its ability to generalize the findings to larger populations. The small sample size also resulted in reduced statistical power (thus increasing the likelihood of Type II errors), less precise estimates, and wider confidence intervals, reducing the certainty of the findings. The small sample size could have also increased the susceptibility of Type I errors due to random variation. The small sample size also affected interaction terms between trimester and predictors. Although treating trimester as a categorical variable was considered, it was treated as an ordinal variable in this study to minimize the complexity of interpretation and address the issue of cells with sparse observations.

This study used real-world data, which inherently included missing data. Although standard GEE models can generally handle missing data, a weighted GEE model, in which a missingness model is specified, would have been the ideal approach. Weighted GEE was attempted in this study, but the models could not run due to missingness patterns in the dataset. Additionally, two multiple imputation approaches (multivariate normal distribution

and fully conditional specification) methods were attempted, but, like Weighted GEE, were unable to properly pool estimates.

Additionally, this study was set in Wisconsin, a state that has not yet legalized adult/recreational use of cannabis and has among the most punitive prenatal substance use policies in the nation. The Unborn Child Protection Act (Act 292), passed in 1997, asserts that pregnant people who use substances can be accused of “unborn child abuse.”<sup>138</sup> Wisconsin is one of a handful of states that allow civil detention for pregnant people accused of substance use. This study used only secondary, de-identified data collected within the safety of a harm reduction program to protect participants. All data were collected as part of a counseling-based interaction between HEs and participants, who had been working together, building trust and safety for many months. Despite these significant protections, it is possible that participants withheld information as a self-protection measure.

This study also had several key strengths. Much of the previous PCU research is cross-sectional, which assumes predictors have the same effect on cannabis use across the prenatal period, which does not reflect reality. Using GEE allowed for examining group-level differences in PCUF trends while incorporating within-subject correlation and the interaction of the predictors and time. This study demonstrated that GEE can be used to measure cannabis use in a way that better matches real-world use patterns. This approach can be applied to studies examining other substance use patterns during pregnancy, such as alcohol, tobacco, and opioids. Further, this approach can examine other important prenatal behaviors and continuous outcomes such as physical activity minutes, folic acid intake days, blood pressure, or mental health screening scores.

Social desirability bias has been noted as a limitation in previous PCU literature but was minimized in this study. Rapport building, careful interview design, and word choice were all used to reduce social desirability bias.<sup>139,140</sup> Finally, this study used data from an existing community-based program, leading to high ecological validity.

## **Conclusion**

The study examined the overall cannabis use trends and whether trends differed based on demographic, psychological, social, and substance use risk factors. Higher preconception cannabis use, higher levels of tobacco-co use, social circle cannabis use, and household cannabis rules were all associated with higher rates of PCUF. The results of this study can be used to develop effective, appropriate, non-punitive prenatal cannabis prevention, intervention, and policy efforts that protect and promote the health of pregnant people, infants, and children.

## **Chapter 3. Multidimensional influences on prenatal cannabis use: A reflexive thematic analysis**

### **Introduction**

#### **Background**

Prenatal cannabis use (PCU) rates have more than doubled in recent years, with an estimated eight percent of birthing people reporting cannabis use during pregnancy in 2022.<sup>1-3</sup> Pregnant people who are younger, unmarried, have mental health conditions, and have lower socioeconomic status are significantly more likely to use cannabis during pregnancy.<sup>12,48</sup> PCU has been associated with a range of adverse birth outcomes such as preterm birth, small for gestational age, lower birth weight, Apgar scores, neonatal intensive care unit (NICU) admissions, and perinatal mortality.<sup>21,34,35</sup> Evidence of a dose-response relationship between PCU and adverse birth outcomes has been observed.<sup>36</sup> Neuroimaging studies have further demonstrated a wide range of long-term physiological, neurodevelopmental, and psychopathological effects on children who were exposed to cannabis prenatally.<sup>39,115</sup>

Major public health and healthcare institutions such as the American College of Obstetricians and Gynecologists, the American Society of Addiction Medicine, and the U.S. Surgeon General advise pregnant people to abstain from cannabis.<sup>118,141,142</sup> However, there are currently no evidence-based strategies to prevent PCU,<sup>120</sup> nor are there evidence-based interventions to reduce cannabis use during pregnancy.<sup>143</sup> A complex combination of historical, political, and social factors has limited efforts to address PCU. Although recent legalization, rescheduling, and decriminalization measures have significantly changed the landscape, there has been little progress in protecting pregnant individuals. In 25 states, prenatal substance use

is considered child abuse under civil child welfare statutes, and in five states, it is grounds for civil commitment.<sup>144</sup>

Qualitative research could be used to design effective PCU prevention, interventions, and policies. However, the few published studies tend to be limited in their scope, focusing on negative experiences with prenatal care providers, risk perception, and knowledge about PCU. Qualitative studies of PCU are almost exclusively set in states where adult use has been legalized,<sup>93,101,103,145</sup> and several studies also used the same sample of birthing people, further limiting diverse perspectives.<sup>83,90,92–96</sup> Other potentially key influences on PCU—including behavioral, relational, psychosocial, and structural factors—have not been examined qualitatively. Very few qualitative studies articulate theoretical frameworks or use community-engaged research approaches.

### **Purpose and Research Question**

This study aims to explore multidimensional influences on PCU, centering the experiences and perspectives of birthing people. This study aims to answer the research question, “How do birthing people describe the behavioral, psychosocial, and structural influences on prenatal cannabis use?”

### **Design**

This study uses reflective thematic analysis (RTA), which emphasizes theoretical flexibility, pattern identification, and researcher reflexivity.<sup>104</sup> RTA was deemed the best approach to handle the (1) exploration of multiple domains of influence, (2) diverse perspectives and experiences of birthing people, and (3) the need to situate the findings within important historical, social, and political contexts.

## **Theoretical Framework**

Lifecourse theory (LCT) guided study conceptualization, the research question, and the interview guide. LCT is both a theory and approach that describes the interplay of accumulating factors that shape people's lives.<sup>111</sup> Glen Elder originally described the five fundamental principles of life course theory as (1) time and place, (2) lifespan development, (3) timing, (4) agency, and (5) linked lives.<sup>114</sup> Time and place describe how individuals are situated in historical, social, and cultural contexts. Life-span development refers to the lifelong process of human development. Timing refers to the behavioral patterns, life transitions, and trajectories (long-term patterns) of people's lives. Agency describes the choices and actions individuals engage in within the constraints and opportunities of individuals' circumstances. Linked lives refer to how individuals are inextricably linked to others through relationships and society.

A critical realist framework was used during the analytic process, staying close to participants' accounts of their experiences situated within historical, local, and policy contexts.<sup>106</sup>

## **Methods**

### **Setting**

This study utilized de-identified secondary data from First Breath, a free, community-based perinatal substance use program in Wisconsin. First Breath collaborates with various prenatal care sites across the state, including OB/GYN clinics, federally qualified health centers, tribal health clinics, Women, Infants, and Children (WIC) programs, and local health departments. Providers at these sites are trained to screen and refer pregnant individuals who use substances to the First Breath program, where they are matched with a local First Breath

Health Educator (HE). HEs are highly trained professionals who deliver individualized education and support from pregnancy through six months postpartum. HEs conducted participant recruitment, obtained consent, and collected data as part of standard program operations. The study was reviewed by the University IRB and deemed exempt due to the use of de-identified secondary data.

### **Sampling and Recruitment**

This study analyzed secondary data that was collected as part of First Breath's 2023 Participant Advisory Group (PAG). During this annual event, participants share their experiences and suggestions regarding perinatal substance use. Purposive sampling was employed to identify First Breath participants who had been pregnant within the past year and reported co-use of cannabis and tobacco during pregnancy.<sup>146</sup> The maximum variation sampling technique was applied to ensure geographic diversity among participants.<sup>146</sup> Between June and August 2023, nineteen participated in the PAG. This number was deemed suitable based on (1) previous PAG participation, (2) alignment with similar qualitative studies,<sup>95</sup> and (3) the typical number of interviews needed to achieve saturation.<sup>147</sup>

### **Data Collection**

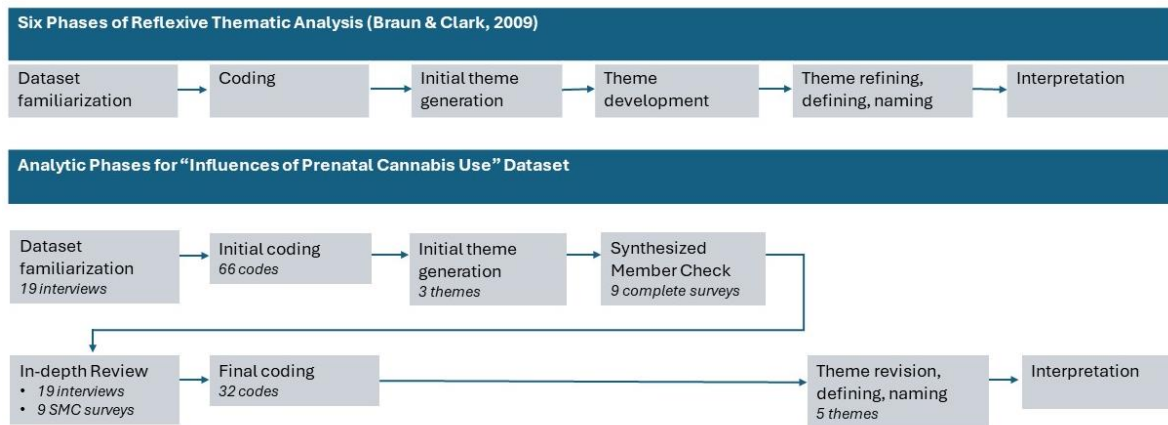
HEs conducted individual interviews (average length 24 minutes) using a semi-structured Interview Guide, found in Appendix B. All interviews were conducted virtually using Microsoft Teams, with the record and transcription functions enabled. Transcripts were downloaded as Word documents, and recordings were saved on a secure, Health Insurance Portability and Accountability Act (HIPAA) compliant network. Transcripts were checked against

the recordings for accuracy and automatically deleted after 120 days. Fifty-dollar Walmart gift cards were sent to participants as a thank you.

## Analysis

De-identified transcripts and participant demographics were shared with the lead author (KA) for analysis. Figure 10 shows the analytic process used, which closely matched the six-phase RTA process recommended by Braun & Clark<sup>148</sup> with slight variations.

**Figure 10.** Reflexive Thematic Analysis Phases



### **Data Familiarization, Initial Coding, and Theme Generation**

KA conducted a thorough review of the transcripts, initially reading them in full and then rereading them while performing hand-coding. A hybrid deductive-inductive approach was employed, guided by the conceptual framework and research question. The coding process was iterative, with codes refined and updated inductively based on emerging patterns in the data.

This process generated 66 initial codes clustered into three initial themes. A draft summary report was crafted with the initial themes, proposed definitions, and selected extracts to help illustrate the themes. The summary report was checked for readability using the Flesch-

Kincaid Grade Level score. The First Breath team reviewed the summary and provided minor edits and adjustments.

### ***Synthesized Member Check***

A member check process was conducted using the Synthesized Member Checking (SMC) methodology.<sup>149</sup> Member checking, also known as respondent validation, is a technique for establishing credibility and trustworthiness in qualitative research.<sup>149</sup> A survey was created using the summary report described above. In the survey, each initial theme was presented, along with the definition and selected text. For each of the three candidate themes, participants were asked (1) how well the theme matched their own experience, (2) what they would change, and (3) what they would add. The full SMC survey can be found in Appendix C.

While SMC often utilizes paper mailing, online surveys are standard practice for the First Breath program and typically result in a high response and completion rate. Two health Educators field-tested the survey to ensure readability and functionality. The HEs contacted participants who agreed to take part in the member check. They reminded them of the goal and allowed them to opt-out if their interest or circumstances changed. If they were still interested and able to complete the member check, the HE sent the SMC survey link, which could be completed on any device, including participants' smartphones. Nine participants completed the SMC survey.

### ***In-depth Review, Final Coding, and Final Theme Development***

KA conducted a second in-depth review and coding of all data, including original interviews and SMC survey responses. This process resulted in 32 final codes and five themes. The number of codes was reduced due to feedback from the SMC survey and second in-depth

review. The initial codes indicated whether certain factors influenced PCU in a certain direction. For example, one code was “partner influence led to more cannabis use” and another code was “partner influence led to less/discontinuation of cannabis use.” In the second round of coding these two codes were grouped together into “partner influence” and the nuances were embraced in the definition of the theme; “for better or worse, partners influence use.” This same approach was used when addressing influences of mental health on PCU. Of the three initial themes, one was broken into two distinct themes, two were revised, and one new theme was added. This final set of five themes was checked for coherence and relevance to the research question and assigned names, definitions, and data extracts. A full list of themes, theme definition, codes, and code definitions can be found in Appendix E.

A reflexivity practice involving journaling, notetaking, and group meetings was used throughout the analytic process to critically examine the ongoing decisions and how the research teams’ values, experiences, and training impacted them.

## **Results**

### **Sample Characteristics**

Nineteen birthing people completed a semi-structured interview. Table 6 shows that most participants were low-income, with 95% insured by Medicaid, nearly half reporting annual household incomes less than \$10,000, and almost 60% unemployed. Fifty-three percent identified as White, and 42% identified as Black. More than two-thirds (63%) reported having a diagnosed mental health condition. Regional representation was mostly achieved.

**Table 6.** Participant Characteristics (n=19)

Characteristic	n	%
Insurance		
Medicaid	18	95%
Private	1	5%
Race		
Black	8	42%
White	10	53%
Missing	1	5%
Annual household income		
Less than \$10,000	9	47%
\$10,000 - \$49,000	6	32%
\$50,000 or more	1	5%
Missing	3	16%
Employed		
Yes	8	42%
No	11	58%
Relationship status		
Married or committed	10	53%
Single	9	47%
Mental health condition		
Yes	12	63%
No	7	37%
Region		
Southeast	7	37%
Southern	8	42%
Northern	2	11%
Northeast	2	11%

## **Themes**

Qualitative analysis resulted in the following five themes: (1) “I tried to stop”: Pregnancy as a turning point in cannabis use, (2) “It helps me not feel everything at once”: Cannabis as an emotional regulator, (3) “You have to dig deeper”: The complicated link between cannabis and mental health, (4) “It changed our dynamics”: For better or worse, relationships influence cannabis use, and (5) “They assume you’re gonna look into the details yourself”: Frustration with the information and support gap

***Theme 1. “I tried to stop”: Pregnancy as a turning point in cannabis use***

Many participants described pregnancy as a turning point that led to them to evaluate their relationship with cannabis. For some, like Participant 5, stopping cannabis use during pregnancy was a relatively straightforward decision. “When I found out [I was pregnant], I stopped. I haven’t picked that back up, and [my baby]’s almost going to be a year.” A few participants made changes to minimize the risk to their baby even though they were unclear about the effects of cannabis use during pregnancy. Participant 8 explained, “I cut back a little to be on the safe side, but there is no actual evidence that it is harmful while pregnant.” On the other extreme, some participants felt quitting cannabis would be harmful to their baby, such as Participant 14, “When I first found out I was pregnant, I was just trying to wean myself off because they tell you, ‘You can’t quit cold turkey. You can put your baby into withdrawal, and it could cause miscarriage.’” For a handful of participants, quitting cannabis was not even considered, like Participant 1, who said, “I didn’t really try to stop – I just didn’t think it was that bad.”

Several participants described the interplay between cannabis and pregnancy-related conditions, like nausea, vomiting, loss of appetite, and chronic pain. For some, like Participant 11, cannabis offered relief, “I attempted to stop, but I was always throwing up. So, it helped with nausea and for me to eat.” For others, like Participant 14, cannabis made their symptoms worse. “When the pregnancy sickness hit, people were like, ‘Oh this will make you feel better.’ Well, for me, that was a lie and made me feel worse. I stopped pretty much cold turkey.”

***Theme 2. “It helps me not feel everything all at once”: Cannabis as an emotional regulator***

Nearly all participants described using cannabis as a tool to help navigate significant stressful life events occurring before and during pregnancy, such as childhood trauma, interpersonal violence, moving, job changes, relationship changes, unintended or mistimed pregnancy, and housing insecurity. For many, this pattern started well before pregnancy, such as Participant 14, who said, “I just remember I had a really messed up childhood, so the first couple times I used it, it gave me that place to go where, you know, I could just not be there.”

During pregnancy, some described antecedent-focused emotional regulation, where cannabis was used to manage future events. Participant 12 said, “Cannabis can help make stressful situations seem not so stressful. So instead of making mountains out of molehills, I can just go with the flow, and I know this will work out.” More commonly, though, cannabis was used as a down-regulation method. Participant 14 said, “When I was down or frustrated or having a hard day, I would smoke, and it would make me feel better. I wouldn’t forget about being mad, but it just didn’t seem as bad when I was high.” Another participant said, “it definitely doesn't, like, fix my stress, but it definitely helps to be able to not feel all of it at once.”

***Theme 3. “You have to dig deeper”: The complicated link between mental health and cannabis***

More than 60% of interview participants had a diagnosed mental health condition, and many described using cannabis to manage their conditions. Of the nine people who completed the SMC follow-up survey, seven endorsed having a mental health condition, and all seven (100%) reported that symptoms of their mental health condition started *before* they started

using cannabis. As Participant 12 described, “I was really depressed as a teenager. I was extremely suicidal, and it really helped with that.”

The use of cannabis to relieve symptoms of mental health conditions persisted into pregnancy, with depression, anxiety, and attention deficit hyperactivity disorder (ADHD) most often noted. Participant 6 explained, “With my ADHD, my mind will go a mile a minute and start all the bad things at once go rushing through your brain nonstop, and they keep pestering you, pestering you. So, for me, it gives that, hey, stop. Calm down. Breathe. You’re fine. You know you can work through this.”

A few mentioned using cannabis to manage serious mental health symptoms. Participant 12 explained, “It definitely impacts [my mental health] as a positive because without it, the voices can get really loud and mean. With it, I can actually go out and do stuff with my kids without fearing that the voices would come back.”

For some participants, using cannabis went deeper than symptom relief. One participant said, “You can't really ever cure depression, but I'd say this is about as close as I'll ever get to a cure.” Several participants preferred cannabis to more commonly prescribed pharmaceuticals, often citing fewer side effects. Participant 6 explains, “It felt a lot more relaxing than a lot of the ADHD or depression medications I was taking at the time.”

Others went on to say that cannabis doesn’t address underlying issues, such as Participant 5, who said, “You have to kind of dig deeper in what’s really causing your stress.” Several described a fine line between using cannabis as a coping mechanism and dependency. Participant 4 said, “Back when I was really depressed, it would bring me out of my depression. But at the same time, I was dependent on it, and that wasn't a good thing. I needed

to figure out how to keep myself out of that depression on my own without substances. It's not something you should be using every single day just to feel right."

Other participants were adamant that cannabis should not be used in place of more formal mental health care, such as Participant 1, who said, "If it's [cannabis use] for mental health, just go to a therapist or a psychologist and actually get mental help because weed isn't gonna help you. If you actually are having psychological issues, you should see a doctor or professional."

***Theme 4. "It changed our dynamics": For better or worse, relationships influence PCU***

While emotional regulation and mental health were by far the most influential on participants' cannabis use, many also described the role people in their lives had on their cannabis use. Social influences began well before pregnancy, with many participants describing how their peers, parents, and siblings impacted their use early on. During pregnancy, participants were influenced more by their partners and the baby's fathers. For some, like Participant 10, this led to more cannabis use. "My ex was a big time weed smoker. So, when he was around, I would smoke. I mean, we *smoked*." For others, like Participant 1, people in their lives influenced them to use less. "My boyfriend stopped smoking, and we decided to stop together." Participant 17, along with a few others, felt changes to their cannabis impacted their relationship. "I think there was a little resentment when I stopped smoking cannabis products. That was something that we had done as a bonding experience. It changed our dynamics."

All participants felt that cannabis was socially acceptable in both their social circles and communities. Participant 14 said, "I would say 95% of people I know smoke," and 6 said, "It's very common, pretty much any city you're in here in Wisconsin." A few mentioned places

where cannabis was not socially acceptable, like Participant 6 who explained, “If you go into hospitals that are run by churches and they know you're using cannabis, they tend to just write you off as a pothead.”

***Theme 5. “They assume you’re gonna look into the details yourself”: Frustration with the information and support gap***

Many participants described frustration at the lack of information and support around PCU. Participants expressed a rapidly changing retail environment that promotes use, noting frustrations with product placement. Referring to psychoactive cannabinoid hemp products, Participant 17 explained, “I've watched them purposely remodel their stores so they can add the clear display cases in the front with cannabis products. The other day, I saw a new candy. I picked up the package right by the register, and it said this contains this amount of THC. I was like, ‘Oh my God, some kid is gonna see this and think it’s actual candy.’” Participant 17, commenting on the lack of cannabis warnings, went on to say, “They just assume you’re gonna look into the details yourself. Or, for some reason, the legislation believes that all of us are potheads already, and we don’t care about the warning.”

While several local municipalities in Wisconsin have passed ordinances loosening restrictions, cannabis in Wisconsin remains illicit. Several participants described Wisconsin’s policies as restrictive and punitive, leading to uneasiness. Participant 5 said, “You have to be discreet, and you know you could get in trouble at any point. I guess there’s always this nervousness.” Several participants commented on the lack of public education about cannabis, and a desire for accessible information was evident. Participant 17 said, “I am very adamant

that this should be more public knowledge. [I wanted] more knowledge and awareness of the effect of marijuana and how the long-term use would affect me in the future.”

## **Discussion**

This study explored the individual, relational, psychosocial, and structural influences on cannabis use from the perspective of birthing people. While all domains influenced birthing people’s use, psychosocial factors, particularly emotional regulation and mental health, were the most influential and important. The PCU literature consistently shows that pregnant people with mental health conditions use cannabis at significantly higher rates than those without,<sup>55</sup> yet little has been done to understand why. Some researchers suggest that cannabis is used to “self-treat” mental health symptoms during pregnancy.<sup>150</sup> While some participants in this study described using cannabis in this way, far more expressed complex motivations, citing multiple types of emotional regulation, grounding, relief from mental health symptoms, and avoidance of side effects associated with more commonly prescribed medications.

Increasing rates of PCU are often attributed to changing policy and retail landscape, improved screening and disclosure, and changing social norms. While participants discussed the influences of cannabis policies and industry on their use, this study opens the door to another potential driver, the mental health crisis. This is in line with other research indicating an association between substance use and unmet mental health needs.<sup>151</sup> System failures in the mental health system are evident, and for many pregnant people, mental health care is not accessible, culturally appropriate, or affordable.<sup>152</sup> Over 60% of pregnant and postpartum people with mental health conditions do not receive mental health services.<sup>153</sup> These findings must be situated within the context of participants’ lives. For example, nearly all participants

described significant stressful life events occurring before and during pregnancy, such as childhood trauma, interpersonal violence, job loss or changes, relationship changes, unintended or mistimed pregnancy, and housing insecurity.

Investments in holistic, innovative, integrated prenatal care services are needed. Treating substance use and mental health are currently siloed, resulting in fragmented care.<sup>154</sup> Thus, efforts to integrate care will require complex, system-level changes. Promising approaches have been noted; for example, one study found that a referral to a perinatal mental health specialist in the first trimester was associated with increased cannabis cessation.<sup>155</sup> A systematic review of integrated substance use and mental health interventions pointed to a wide range of approaches, including psychoeducation and psychological interventions.<sup>154</sup> However, few of these approaches were rigorously evaluated for their efficacy.

Beyond the integration of substance use and mental health, this study has several other implications for public health practice and policy. Public health agencies should take responsibility for assuring access to unbiased and scientifically accurate information to allow birthing people to make informed decisions about their cannabis use. Previous research has shown the most common place for pregnant people to gain information about PCU is in the digital environment, where the risk of misinformation and predatory marketing is high.<sup>93,103</sup> However, a content analysis of public health websites found that only about 20% of federal and state agencies had published information about perinatal cannabis use on their websites.<sup>156</sup>

According to the Substance Abuse and Mental Health Services Administration, there is currently “no evidence on individual programs for the prevention of marijuana use among pregnant and postpartum women.”<sup>120</sup> While the use of evidence-based tools such as

Screening, Brief Intervention, and Referral to Treatment has shown promise in clinical settings,<sup>157</sup> more research is needed in prenatal populations who use cannabis. Efforts are needed to develop, implement, and evaluate person-centered, harm-reduction, and scientifically based interventions.

Community-engaged practices and partnerships with clinical, community, and retail partners will be critical to successful implementation. However, these efforts will not be without challenges. Structural bias has been well-documented in PCU screening, reporting, and counseling.<sup>49,158</sup> Research has shown that up to two-thirds of pregnant people did not disclose cannabis use with their provider, citing judgment and fear of being reported to child protective services.<sup>101,103</sup> Those who did disclose use describe inconsistent, punitive, and generally unhelpful information.<sup>93,145</sup> Thus, efforts must center on health equity and be committed to dismantling structural bias.

None of the approaches described here will result in critically needed change and support for birthing people if significant policy changes do not occur. Punitive policies around prenatal substance use lead to a range of adverse birth and child health outcomes<sup>159</sup> and contribute to an environment of fear, distrust, and confusion.<sup>84</sup> Thus, civil child welfare statutes and reporting requirements should be updated to (1) remove substance use as grounds for child abuse and/or civil commitment and (2) remove reporting requirements for substance use in state statutes. Additional actions called for by the American Public Health Association include (1) providing protection to vulnerable populations through product, advertising, and labeling regulations, (2) minimizing harm through prevention education, clean indoor air, and adoption of health equity policies, and (3) monitor patterns of use.<sup>160</sup>

## **Strengths and Limitations**

This study had several key strengths. RTA allowed for a systemic and flexible approach to a unique dataset and protected population. Lifecourse theory guided the exploration of critical cumulative stressors and contextual influences on PCU. SMC allowed participants to engage with the research process and strengthened the critical realist approach. Social desirability bias has been noted as a limitation in previous PCU literature but was minimized in this study. Rapport building, careful interview design, and word choice were all used to reduce social desirability bias. Finally, this study used data from an existing community-based program, leading to high ecological validity. However, care must be taken not to use these findings to make broader assumptions about PCU. The local setting and socio-political context were essential factors in interpreting the results.

This study had some limitations. This study used secondary data from pregnant people who participated in a voluntary program, leading to selection bias. These participants potentially had access to more information, support, and resources than pregnant people who did not participate. At the time of this study, adult recreational use of cannabis was restricted in Wisconsin. While this study used only secondary, de-identified data collected as part of a counseling-based interaction between HEs and participants, it is possible that participants withheld information as a self-protection measure.

## **Conclusion**

This study provides a holistic picture of PCU, exploring individual, psychosocial, and structural influences using a life course perspective. The use of cannabis to (1) regulate emotions and (2) manage mental health conditions during pregnancy were the most important

findings. Partners also played a role in influencing PCU among birthing individuals, with this influence occurring in both directions. This study highlights the importance of addressing mental health and substance use before and during the perinatal period. Multi-disciplinary, community-engaged, equity-informed approaches are needed to address PCU and protect the health of pregnant people and their families.

## **Chapter 4. Prenatal cannabis-tobacco co-use reasons, behaviors, and experiences: A mixed-methods, convergent parallel study**

### **Introduction**

#### **Background**

Co-use, also called polysubstance use, is common<sup>161</sup> and encompasses a range of behavioral patterns. Concurrent co-use refers to the use of two or more substances within a given timeframe. Simultaneous use is a form of concurrent use involving the use of two or more substances on the same occasion, such that their effects overlap.<sup>162</sup> Coadministration – or mixing - is a term most often used to describe cannabis-tobacco co-use (CTCU), typically in the form of a blunt (hollowed-out cigar wrapper filled with cannabis) or spliff (rolling paper with tobacco and cannabis mixed).<sup>163,164</sup>

Fourteen percent of adults reported CTCU in the past year<sup>164</sup> and use among vulnerable populations, particularly pregnant people, is a growing public health concern. While cigarette smoking during pregnancy has declined in the US,<sup>165</sup> rates of prenatal cannabis use have more than doubled in recent years.<sup>1,166</sup> According to data from the National Survey on Drug Use and Health (NSDUH), 3.3% of pregnant people reported past month CTCU,<sup>167</sup> however, studies from clinical or community settings indicate much higher rates.<sup>65</sup> Additionally, an estimated 2% of pregnant people report blunt usage,<sup>168</sup> which is a particular concern given the additive risk of toxicant exposure.<sup>63</sup>

The prevalence of prenatal CTCU and prenatal cannabis use in general is likely underestimated due to several factors. First, cannabis was federally classified as a Schedule I substance for over five decades, rendering it illegal at the federal level and thereby

discouraging self-reporting.<sup>95</sup> Second, systemic racism may contribute to disparities in surveillance and reporting, particularly among marginalized populations.<sup>75</sup> In multiple states, prenatal substance use is deemed child abuse under civil child welfare laws, and in five states, it is grounds for civil commitment.<sup>144,169</sup> This criminalization of substance use during pregnancy introduces a significant barrier to accurate disclosure, as pregnant individuals may fear legal consequences or social stigmatization.<sup>95</sup>

Independently, prenatal tobacco exposure is one of the most significant preventable causes of maternal, fetal, and infant morbidity and mortality.<sup>170</sup> The evidence regarding the independent effects of prenatal cannabis use (PCU) on health outcomes is less robust, as research rarely accounts for variations in cannabis use like frequency, timing, dose, and administration method.<sup>31</sup> An increasing body of evidence is emerging, showing PCU to be independently associated with low birth weight,<sup>17,34,35</sup> small for gestational age,<sup>34,35</sup> preterm birth,<sup>34,35</sup> neonatal intensive care unit admissions,<sup>34</sup> and perinatal mortality.<sup>35</sup> Neuroimaging studies offer additional evidence of adverse physiological, neurodevelopmental, and psychological effects on exposed offspring.<sup>39,115</sup>

Given the independent impact of each substance on health outcomes, it is unsurprising that CTCU is associated with a range of adverse birth, infant, and maternal health outcomes.<sup>64</sup> Emerging research shows that CTCU increases risk over either substance alone, suggesting a synergistic effect.<sup>63</sup> For example, the risk of small for gestational age,<sup>64</sup> small head circumference,<sup>65,66</sup> low birth weight,<sup>66</sup> preterm birth,<sup>64,66</sup> congenital disabilities,<sup>65</sup> and neonatal and infant death<sup>64</sup> are higher among co-users when compared to either substance alone.

Leading public health and healthcare institutions such as the American College of Obstetricians and Gynecologists, the American Academy of Pediatrics, the American Society of Addiction Medicine, and the U.S. Surgeon General all advise pregnant people to abstain from cannabis and tobacco.<sup>118,141,171</sup> While there are evidence-based practices to address prenatal tobacco,<sup>172</sup> there are currently no evidence-based practices or interventions to address prenatal cannabis or CTCU.<sup>120</sup>

Several significant gaps in the literature limit the ability to understand and address CTCU effectively. While there is a growing body of evidence around the health effects of prenatal CTCU, there is little insight into why pregnant people co-use, how their behaviors change over the prenatal period, and how their use of one substance impacts the other. To the authors' knowledge, no qualitative or mixed methods studies have been conducted on prenatal CTCU, leaving the lived experiences of pregnant co-users largely missing from the literature.

### **Research Questions and Hypotheses**

This descriptive, mixed-methods study examined prenatal CTCU reasons, behaviors, and experiences. It accomplished this through the following research questions and hypotheses:

#### ***Research Question 1***

Research question one is, "What are the most common reasons for tobacco and cannabis use during pregnancy, and do certain reasons influence quit outcomes?" The following hypotheses were tested:

1. Birthing people's reasons for using cannabis and tobacco will differ.

2. Birthing people who report using substances for mental health reasons will continue to use substances during pregnancy compared to those who don't use substances to manage mental health.

### ***Research Question 2***

Research question two is: "What is the relationship between quit intentions, attempts, and outcomes by substance?" The following hypotheses were tested:

1. There will be differences between quit intentions, attempts, and outcomes for both cannabis and tobacco.
2. Birthing people who intend to quit will be more likely to report tobacco and cannabis quit attempts than birthing people who did not intend to quit.
3. Birthing people who intend to quit will be more likely to quit tobacco and cannabis than birthing people who did not intend to quit.
4. Birthing people who attempted to quit will be more likely to have quit tobacco and cannabis than birthing people who did not attempt to quit.

### ***Research Question 3***

Research question three is, "What is the relationship between quit intentions, attempts, and outcomes by co-use category?" The following hypotheses were tested:

1. There will be differences between quit intentions, attempts, and outcomes by co-use category.
2. Birthing people who intend, attempt, and quit tobacco will be more likely to intend to, attempt to, and quit cannabis.

#### **Research Question 4**

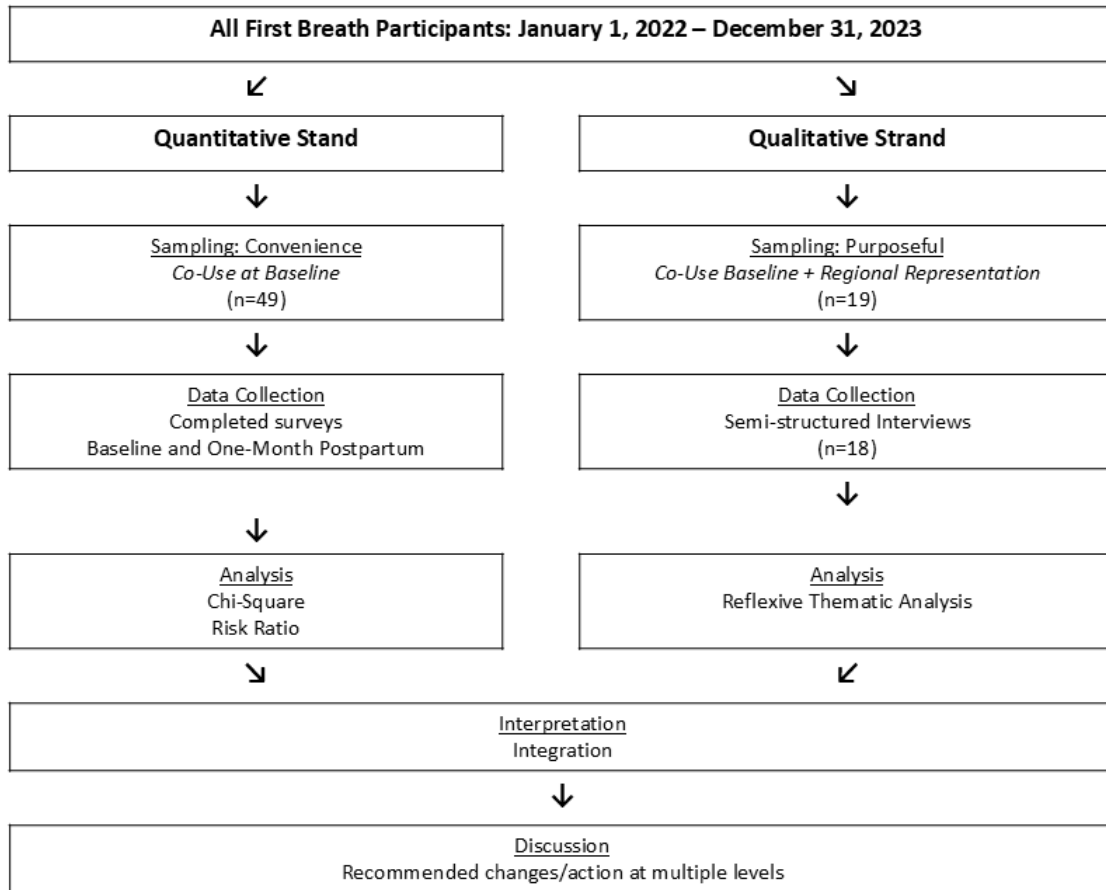
The fourth research question is qualitative in nature and asks, “How do birthing people describe their experiences with tobacco and cannabis co-use during pregnancy?” The following three domains were examined:

1. What are the reasons birthing people use tobacco and cannabis during pregnancy?
2. How do birthing people describe quit intentions, attempts, and outcomes by substance?
3. How do birthing people describe their experiences with CTCU?

#### **Design**

This mixed methods study used a convergent parallel design to compare qualitative and quantitative datasets and interpret where the data converged, diverged, or were contradictory.<sup>97</sup> As shown in Figure 11, qualitative and quantitative data were treated separately during the data collection and analysis phase and then mixed during the overall interpretation of the findings.<sup>98,99</sup> Quantitative and qualitative data were weighted equally, centering on participants' voices and experiences.<sup>99</sup> A mixed-methods approach was selected to (1) enhance data validity and (2) reduce the risk of partial or incomplete interpretation.<sup>97</sup>

**Figure 11.** Mixed Methods Convergent Parallel Design Flow



## Methods

### Setting

This study used de-identified secondary data from *First Breath*, Wisconsin's free, community-based, perinatal substance use program. The First Breath program partners with various prenatal care locations throughout the state, including OB/GYN clinics, federally qualified health centers (FQHCs), tribal health clinics, Women, Infants, and Children (WIC) programs, local health departments, and more. Providers at these sites are trained to screen and refer pregnant people who use tobacco and other substances to the First Breath program,

where they are matched with a local First Breath Health Educator (HE). HEs are highly trained professionals who provide one-to-one education and support to pregnant people from pregnancy through six months postpartum. HEs conducted recruitment, consent, and data collection as part of standard program operations. The University IRB reviewed the study and determined it to be exempt due to the exclusive use of deidentified secondary data.

### **Sampling and Recruitment**

#### ***Quantitative***

The study examined survey data from participants enrolled in First Breath between January 1, 2022, and December 31, 2023. To be eligible for the program, participants must have resided in Wisconsin, been pregnant, and reported any substance use at enrollment. Data used in this study was restricted to participants who completed a baseline survey, reported both cannabis and tobacco use at the baseline survey, and completed a follow-up survey at one month postpartum.

#### ***Qualitative***

This study used secondary data collected through First Breath's Participant Advisory Group (PAG). Participants share their experiences, feedback, and suggestions about perinatal substance use with the First Breath program in this annual event. Between June and August 2023, birthing people participated in virtual, semi-structured interviews with their HE. Purposive sampling<sup>146</sup> was to identify First Breath participants who were pregnant within the last year and reported cannabis and tobacco co-use during pregnancy. The maximum variation technique<sup>146</sup> was used to recruit geographically diverse participants. Interview data used in this

study were restricted to nineteen birthing people who reported prenatal cannabis and tobacco co-use.

## **Data Collection**

### ***Quantitative***

Quantitative data were drawn from surveys administered by HEs at two time points: baseline (first trimester) and one month postpartum. Baseline surveys were conducted over the phone by HEs during the enrollment process. Data included demographic information, current substance use, intent to quit, and reasons for tobacco and cannabis use. The one-month postpartum survey was conducted in a virtual (video chat) coaching session. Data collected at this time point included participants' attempts to quit and quit outcomes for both prenatal tobacco and cannabis use. HEs entered all survey responses into Alchemer,<sup>173</sup> a secure and Health Insurance Portability and Accountability Act (HIPAA) -compliant online data management system using the participants' unique identifiers.

### ***Qualitative***

HEs conducted semi-structured interviews using an Interview Guide found in Appendix B. All interviews were conducted using Microsoft Teams, with the record and transcription functions enabled. Interview transcripts were downloaded as Word documents, and recordings were saved on a secure, HIPAA-compliant network. Transcripts were checked against the recordings for accuracy, and edits were made. The recordings were automatically deleted after 120 days. Fifty-dollar Walmart gift cards were sent to participants as a thank you. HEs invited participants to review preliminary results via a synthesized member check (SMC) process,<sup>149</sup> which was administered as a confidential online survey.

## **Measures**

### ***Demographics***

Demographic data were collected during the baseline survey. This included participants' age, education level (less than high school, high school or GED, more than high school), employment status (employed, unemployed), relationship status, racial/ethnic identity, and household income (less than \$10,000, \$10,000 - \$29,999, \$30,000 - \$49,999, and more than \$50,000).

### ***Baseline Use***

At the baseline survey, participants reported their past 30-day cannabis use and past 7-day tobacco use. Participants also reported all current modes of administration for cannabis (smoking, vaping, edibles, dab, and/or oils) and tobacco products used (cigarettes, e-cigarettes, cigars/cigarillos, and/or other tobacco products).

### ***Reasons for Use***

At the baseline survey, participants indicated their reasons for using cannabis and tobacco use from a checklist of multiple items. For each substance, participants selected one or more of the following reasons for use: fun/enjoyment, stress relief, to manage symptoms of a mental health condition, escape from problems, to handle certain situations/people, to feel calm/relaxed/level, social reasons, boredom, to manage physical ailments, and/or habit/addiction. This question was co-developed with participants and underwent cognitive testing in 2021.

### ***Intent to Quit***

At baseline, participants were asked about their goals for their cannabis use and tobacco use during pregnancy. For each substance, participants selected one of the following: (1) quit for good, (2) quit for the perinatal period, (3) cut down for good, (4) cut down for a perinatal period, (5) no change, and (6) increase use. Due to small cell counts, responses were dichotomized into “intent to quit” (options one and two) or “continue using” (options three through six).

### ***Attempt to Quit***

The one month postpartum visit included a “pregnancy lookback” section. Participants were asked if they made any attempts to change their tobacco use during pregnancy (yes or no) or if they made any attempts to change their cannabis use during pregnancy (yes or no).

### ***Quit Status***

Previously completed prenatal surveys were reviewed by HEs, who then answered two questions: (1) “Which best describes this participant’s change in tobacco use from baseline through delivery?” and (2) “Which best describes this participant’s change in cannabis use from baseline through delivery?” Responses to each question included: (1) quit, (2) cut down, (3) no change, (4) increased use, and (5) variable. Due to small cell counts, responses were dichotomized into “quit” (option one) or “not quit” (options two through five).

### ***Intervention Dose***

HEs recorded the total number of minutes spent counseling the participant during pregnancy.

### ***Qualitative Questions***

Several open-ended questions were drawn from larger semi-structured interviews (Appendix B) and the SMC survey (Appendix C). The questions used in this study included (1) Tell me about your attempts to change your tobacco use during pregnancy, (2) What had the biggest impact on your tobacco use or cessation during pregnancy, (3) Tell me about your attempts to change your cannabis use during pregnancy, (4) What had the biggest impact on your tobacco use or cessation during pregnancy, (5) Can you explain more about why you co-use cannabis, and (6) Can you explain more about how you co-use cannabis and tobacco?

### **Analysis**

#### ***Quantitative***

Two de-identified datasets were obtained from First Breath: baseline and one-month postpartum. Data were linked by participants' six-digit IDs and restricted to participants who (1) reported both cannabis and tobacco at baseline and (2) completed both a baseline and one-month postpartum survey (n= 46). The merged dataset was imported into SAS<sup>®</sup> Studio OnDemand for Academics, Copyright © 2023 SAS Institute Inc.<sup>127</sup>

To test the first hypothesis for research question one, the common reasons for use were summarized using frequencies and proportions. Logistic regression was used to examine the impact of different reasons for use on quit outcomes. To test hypotheses for research question three, overall frequencies and proportions of intent, attempt, and quit outcomes by substance were examined.

Next, two-by-two contingency tables were constructed to examine differences in (1) quit intent and attempts, (2) quit intent and outcomes, and (3) quit attempts and outcomes by

each substance. Fisher's Exact test was used to examine whether these differences were statistically significant. Fisher's Exact was selected over Chi-square due to the small sample size and low cell counts. Finally, logistic regression was used to examine the influence of intent and attempt on outcomes. Results were calculated as unadjusted and adjusted risk ratios along with 95% confidence intervals and p-values.

To test hypotheses for research question three, participants were grouped into three mutually exclusive co-use categories: (1) quit both cannabis and tobacco, (2) quit one substance (either cannabis or tobacco), and (3) quit neither substance. First, overall frequencies and proportions were examined. Next, three-by-three contingency tables were constructed to examine differences in (1) quit intent and attempts, (2) quit intent and outcomes, and (3) quit attempts and outcomes by each co-use category. Logistic regression was used to examine the impact of tobacco quit intent, attempts, and outcomes on cannabis quit intent, attempts, and outcomes. Results are presented as unadjusted and adjusted risk ratios along with 95% confidence intervals and p-values.

### ***Qualitative***

Reflexive Thematic Analysis (RTA) was conducted to answer research question four, following Braun and Clarke's six-phase process with minor adaptations. The lead author (KA) initially read all transcripts and then re-read them while manually coding the data deductively. This process generated preliminary codes, which were grouped into three initial themes. These themes were shared with the Health Educators (HEs), who distributed them through an online Synthesized Member Check (SMC) survey sent to participants who agreed to be recontacted. The SMC survey aimed to (1) evaluate how well the initial themes reflected participants'

experiences and (2) ensure ethical protection by preventing the inadvertent reproduction of harmful stereotypes. A second round of thorough data review and coding was conducted, incorporating the original interviews and SMC survey responses. This produced 14 final codes and a set of three finalized themes. Each theme was given a name, definition, and supporting data extracts. The interpretation was data-driven and shaped by the research aims. The First Breath program reviewed the final interpretation to ensure clarity and accuracy.

## **Results**

### **Descriptives**

Forty-six pregnant people were included in the quantitative analysis and nineteen in the qualitative analysis. Table 7 shows that most participants were low-income, with more than 90% insured by Medicaid, nearly half reporting annual household incomes of less than \$10,000, and nearly 60% unemployed. In both survey and interview data, around half identified as White, and around 40% identified as Black. Additionally, in both survey and interview data, around two-thirds reported having a diagnosed mental health condition. At baseline, participants were using cannabis an average of 13.2 days in the past month (standard deviation 13.0), and most were smoking five or fewer cigarettes per day. Most participants reported smoking cannabis (71.7%), but other modes of administration were reported, such as vaping cannabis (13%), and edibles (9%). Similarly, most participants reported smoking tobacco (78%), but more than one-third used cigars or cigarillos, and more than a quarter reported vaping.

**Table 7.** Participant characteristics

Characteristic	Survey (Quantitative) n=46		Interview (Qualitative) n=19	
	n	%	n	%
<b>Insurance</b>				
Medicaid	41	93.18	18	94.74
Private	3	6.82	1	5.26
<b>Race</b>				
Black	18	40.91	8	42.11
White	22	50.00	10	52.63
Other	4	9.09	0	0.00
<b>Annual household income</b>				
Less than \$10,000	20	46.51	9	47.37
\$10,000 - \$29,999	10	23.26	1	5.26
\$30,000 - \$49,000	8	18.60	5	26.32
More than \$50,000	5	11.63	1	5.26
<b>Employed</b>				
Not employed	26	57.78	11	57.89
Employed part-time	8	17.78	1	5.26
Employed full-time	11	24.44	7	36.84
<b>Education</b>				
Less than high school	6	13.33	2	10.53
High school	17	37.78	7	36.84
More than high school	22	48.89	10	52.63
<b>Relationship status</b>				
Single	19	42.22	10	52.63
Married/committed	26	57.78	9	47.37
<b>Mental health condition</b>				
Yes	30	33.33	12	63.16
No	15	66.67	7	36.84
<b>Age</b>				
	27.46 (m)	5.33 (sd)	27.95 (m)	4.27 (sd)
<b>Past 30-day cannabis use (baseline)</b>				
	13.24 (m)	13.03 (sd)	-	-
<b>Cannabis administration mode<sup>a,b</sup></b>				
Smoked	33	71.74	-	-
Vaped	6	13.04		
Edibles	4	8.70		
<b>Past 7-day cigarette use (baseline)</b>				
Less than 1 per day	10	25.64	-	-
1-5	18	46.15		
6 or more	11	28.21		
<b>Tobacco administration mode<sup>a,b</sup></b>				
Smoked cigarettes	36	78.26	-	-
Smoked cigars/cigarillos	13	28.26		
Vaped	12	26.08		
Other products (chew, dip)	1	2.17		

<sup>a</sup> Participants could choose more than one mode; <sup>b</sup> Data on interview participants' past 30-day cannabis use, cannabis administration mode, past 7-day tobacco use, and tobacco administration mode was not obtained

## **Research Question 1**

Research question one is, “What are the most common reasons for tobacco and cannabis use during pregnancy, and do certain reasons influence quit outcomes?”

### ***Hypothesis 1***

To answer research question one, the following hypothesis was tested: “Birthing people's reasons for cannabis and tobacco use will differ.” When asked about their reasons for using tobacco during pregnancy, overwhelmingly, participants said “stress relief” (86.96%). More than half also said they used tobacco prenatally to “manage mental health symptoms” (54.35%) and because of a “habit or addiction” (54.35%). When asked about their reasons for using cannabis during pregnancy, more than half of pregnant people said to “feel calm, relaxed, or level” (56.52%) and for “stress relief” (52.17%). Other top reasons for prenatal cannabis use included “to manage mental health symptoms” (43.48%) and “social reasons” (43.48%). Based on these findings and the significant overlap of top reasons for use, hypothesis one was rejected.

### ***Hypothesis 2***

To further answer research question one, the following hypothesis was tested, “birthing people who report using substances for mental health reasons will continue to use substances during pregnancy compared to those who don’t use substances to manage mental health. In logistic regression models, reasons for use did not predict cannabis quit outcomes, except for using cannabis to manage stress. In unadjusted models, birthing people who endorsed using cannabis to manage stress were more than four times as likely to continue using cannabis compared with those who did not report using cannabis to manage stress (RR 4.25, 95% CI

1.23-14.64,  $p=0.02$ ). However, after adjusting for mental health diagnosis and intervention dose, this association was no longer significant. Hypothesis two was also rejected.

**Research Question 2**

Research question two examined the relationship between quit intentions, attempts, and outcomes for each substance, cannabis and tobacco.

***Hypothesis 1***

To answer research question two, the following hypothesis was tested: “There will be differences between quit intentions, attempts, and outcomes for both cannabis and tobacco.” As shown in Table 8, while most participants (87%) intended to quit tobacco and most (87%) attempted to quit, only about 40% quit tobacco. This contrasts with cannabis where just 18 participants (39%) intended to quit cannabis; however, 65% reported they attempted to quit, and 46% quit. While quit rates for tobacco and cannabis were identical, the behavioral intentions and attempts leading up to those outcomes look quite different, so the hypothesis was accepted.

**Table 8.** Quit Intentions, Attempts, and Outcomes by Substance

	<b>Intended to quit</b>	<b>Attempted to quit</b>	<b>Quit</b>
Tobacco	Yes: 40 (86.96%) No: 6 (13.04%)	Yes: 40 (86.96%) No: 6 (13.04%)	Yes: 19 (41.30%) No: 27 (58.70%)
Cannabis	Yes: 18 (39.13%) No: 28 (60.87%)	Yes: 30 (65.22%) No: 16 (34.78%)	Yes: 21 (45.65%) No: 25 (54.35%)

***Hypothesis 2***

To further answer research question two, the following hypothesis was tested, “Birthing people who intend to quit will be more likely to report tobacco and cannabis quit attempts than

birthing people who did not intend to quit.” While these differences were not statistically significant, they do reveal unexpected patterns. As shown in Table 9, among those who intended to quit tobacco (n=40), nearly all (90%) attempted to quit. Among those who intended to quit cannabis (n=18), more than three quarters (78%) also attempted to quit. Importantly, even among those who did not intend to quit tobacco (n=6), nearly two-thirds made a quit attempt. Similarly, among those who did not intend to quit cannabis (n=28), more than half (57%) made a quit attempt. In logistic regression models, intentions did not predict quit attempts for tobacco or cannabis. Based on these findings, hypothesis two was rejected.

**Table 9.** Fisher’s Exact Test for Differences in Quit Intentions and Attempts by Substance

	Quit Intention (Baseline)	Quit Attempt (Postpartum)		p-value
		Attempted	Did not attempt	
Tobacco	Intent to quit (n=40)	36 (90.00%)	4 (10.00%)	0.17
	No intent to quit (n=6)	4 (66.67%)	2 (33.33%)	
Cannabis	Intent to quit (n=18)	14 (77.78%)	4 (22.22%)	0.21
	No intent to quit (n=28)	16 (57.14%)	12 (42.86%)	

### **Hypothesis 3**

To further answer research question two, the following hypothesis was tested, “Birthing people who intend to quit will be more likely to quit tobacco and cannabis than birthing people who did not intend to quit. As shown in Table 10, Among those who intended to quit tobacco (n=40), a little less than half (45%) ended up quitting tobacco. Among those who did not intend to quit, most (83%) continued using tobacco throughout pregnancy. Among those who intended to quit cannabis, a little more than half (55.56%) quit cannabis. Interestingly, among those who did not intend to quit cannabis (n=28), nearly 40% ended up quitting. While differences were not statistically significant, the patterns demonstrated the complexities of quit

behaviors. In logistic regression models, intentions did not predict quit outcomes for tobacco or cannabis. Based on these findings, hypothesis three was rejected.

**Table 10.** Fisher’s Exact Test for Differences in Quit Intentions and Outcomes by Substance

	Quit Intention (Baseline)	Quit Outcomes (Postpartum)		p-value
		Quit	Did not quit	
Tobacco	Intent to quit (n=40)	18 (45.00%)	22 (55.00%)	0.16
	No intent to quit (n=6)	1 (16.67%)	5 (83.33%)	
Cannabis	Intent to quit (n=18)	10 (55.56%)	8 (44.44%)	0.37
	No intent to quit (n=28)	11 (39.29%)	17 (60.71%)	

**Hypothesis 4**

To further answer research question two, a final hypothesis was tested, “Birthing people who attempted to quit will be more likely to have quit tobacco and cannabis than birthing people who did not attempt to quit.” As shown in Table 11, among those who attempted to quit tobacco (n=40), just over a third ended up quitting (35%), while more than two-thirds (65%) did not quit. Among the those who attempted to quit cannabis (n=30), nearly half (47%) quit and half did not (53%). In the Fisher’s Exact test, there was a significant difference between a quit attempt and outcome for tobacco (p=0.03) but not for cannabis, meaning that quit attempt and outcome were significantly associated when it came to tobacco, but not cannabis. In logistic regression models, quit attempts did not predict quit outcomes for tobacco or cannabis. Based on these findings, hypothesis four was accepted for tobacco but not cannabis.

**Table 11.** Fisher’s Exact Test for Differences in Quit Attempt and Outcome by Substance

	Quit Attempt (Postpartum)	Quit Outcomes (Postpartum)		p-value
		Quit	Did not quit	
Tobacco	Attempted to quit (n=40)	14 (35%)	26 (65%)	<b>0.03*</b>
	Did not attempt (n=6)	5 (83.33%)	1 (16.67%)	
Cannabis	Attempted to quit (n=30)	14 (46.67%)	16 (53.33%)	0.24
	Did not attempt to quit (n=16)	7 (43.75%)	9 (56.25%)	

### **Research Question 3**

Research question three examined the relationship between quit intentions, attempts, and outcomes by co-use category. To test the hypotheses, participants were grouped into three mutually exclusive categories: (1) quit both tobacco and cannabis, (2) quit one (tobacco or cannabis), or (3) quit neither (continue using both tobacco and cannabis).

#### ***Hypothesis 1***

The following hypothesis was tested: "There will be differences between quit intentions, attempts, and outcomes by co-use category." As shown in Table 12, among all participants, 17 (37%) intended to quit both tobacco and cannabis, 27 (28%) attempted to quit both, and 13 (38%) quit both substances. More than half (52%) of participants intended to quit one substance (tobacco or cannabis). Around a third of all participants (35%) attempted to quit one substance, and a third (30%) quit one substance. While only five participants (11%) had no intentions of quitting either substance, 41% of all participants continued using both substances throughout their pregnancies.

**Table 12.** Quit Intentions, Attempts, and Outcomes by Co-Use Pattern (n=46)

	<b>Intent</b>		<b>Attempt</b>		<b>Outcome Matched Intent<sup>a</sup></b>	
	Yes	No	Yes	No	Yes	No
Quit Both	17 (36.96)	29 (63.04)	27 (28.26)	19 (41.30)	13 (28.26)	33 (71.74)
Quit One	24 (52.17)	22 (47.83)	16 (34.78)	30 (65.22)	14 (30.43)	32 (69.57)
Quit Neither	5 (10.87)	41(89.13)	N/A	N/A	19 (41.30)	27 (58.70)

a Outcome is coded as “yes” when it matched the quit intention. This is an important note when examining the “quit neither” group, where outcome = yes means these individuals quit neither (continued using both) cannabis and tobacco.

Examining quit attempts and outcomes by intention reveals additional complexities. As shown in Table 13, among the seventeen participants who intended to quit both substances, more than 70% attempted to quit both, but at the end of pregnancy, only 29% quit both. Although they intended to quit both, an additional 24% attempted to quit one substance, and 30% quit one substance. Another way to look at the data is that 59% of these individuals quit *at least* one substance.

Among the 24 participants who intended to quit just one substance, 46% attempted to quit one substance, and 33% quit one substance. Although it was not their initial intention to quit both substances, 50% attempted to quit both, and 11% quit. Interestingly, of the five people who intended to continue using both, 60% ended up attempting to quit both, and another 20% attempted to quit one substance. Despite these attempts, 80% ultimately continued to use both substances throughout their pregnancies. Based on these findings, hypothesis one was accepted.

**Table 13.** Quit Attempts and Outcome by Co-Use Intention (n=46)

<b>Intentions</b>	<b>Quit attempts</b>			<b>Quit outcomes</b>		
	Attempted both	Attempted one	Did not attempt	Quit both	Quit one	Continued using both
Intend to quit both (n=17)	12 (70.59)	4 (23.53)	1 (5.88)	5 (29.41)	5 (29.41)	7 (41.18)
Intend to quit one (n=24)	12 (50.00)	11 (45.83)	1 (4.17)	8 (33.33)	8 (33.33)	8 (33.33)
Intend to continue using both (n=5)	3 (60.00)	1 (20.00)	1 (20.00)	0 (0.00)	1 (20.00)	4 (80.00)

## ***Hypothesis 2***

To further answer research question three, the following hypothesis was tested, “Birthing people who intend, attempt, and quit tobacco will be more likely to intend to, attempt to, and quit cannabis.” Logistic regression was used to examine the influence of tobacco behaviors on cannabis behaviors, including quit intent, quit attempts, and quit outcomes. Intent to quit tobacco was not associated with intent to quit cannabis. Similarly, attempts to quit tobacco were not associated with an attempt to quit cannabis. In unadjusted models, birthing people who quit tobacco were twice as likely to have also quit cannabis (RR=2.11, 95% CI 1.03-4.34). However, after adjusting for race, income, and intervention dose, the tobacco and cannabis quit status association was no longer significant. Thus, hypothesis two was rejected.

## **Research Question 4**

### ***Domain 1***

The first domain of the qualitative component of this study examined reasons for use by substances. In qualitative interviews, nearly all participants described using both cannabis and tobacco to manage mental health conditions and stress. For example, participant 6 said, “It [cannabis] felt a lot more relaxing than a lot of the ADHD and depression medications I was taking.” Several people traced this connection to childhood or adolescence, like Participant 12, who said, “I was being molested; let’s just get that out there and open. I used them [tobacco and cannabis] as a coping mechanism. It was a bad habit, but it worked. It was there for me.”

Many participants described complex and nuanced feelings about their reasons for use. Some described a cycle of substance use and stress, particularly when it came to tobacco. For

example, Participant 6 said, “It’s that double-edged sword again. I use it because I’m stressed, but the more I smoke, the more it stresses me out. So, it’s that constant back-and-forth battle.” Participant 10 explained, “If I was angry, upset, stressing...that cigarette was the relief. But then, if I didn’t have a cigarette, my stress levels went up. So, it was a lose-lose situation.”

Many participants indicated that their use of cannabis and tobacco, although briefly effective, did not fix deeper issues. Participant 4 described cannabis use as a temporary fix, “It’s not permanent, you have to kind of dig deeper into what’s really causing your stress.” Participant 3 described it as a false need to manage, “you figure that’s just something you need, when really you don’t.” Participant 4 explained “It [cannabis] has had a positive impact on my mental health here and there. It would bring me out of my depression. But at the same time, I was dependent on it. I needed to figure out how to keep myself out of the depression on my own without substances.”

## ***Domain 2***

The second domain examined participants' descriptions of their quit intentions, attempts, and outcomes by substance. In semi-structured interviews, participants expressed very different accounts of their quit intentions and attempts by substance. Most participants described an intense and passionate desire to quit tobacco, like Participant 18, who said, “I can go on about everything that smoking has destroyed in my life. I hate smoking, I really do.” When describing their tobacco quit attempts, participants expressed deep frustration, desperation, or hopelessness. One participant said, “I’ve tried the patch to quit smoking and that didn’t help. I’m on a depression medication right now that is also to help quit smoking, and that didn’t even help. So, like, I don’t know what to do anymore.” Participant 10 said, “It’s very

challenging. The cravings are really hard. I've been smoking for so long." Participant 1 said, "I tried cold turkey at first and that was just terrible. It made me feel so much worse while already having morning sickness and not being able to eat."

Participants who attempted to quit tobacco described detailed, meticulous plans and strategies to cut down or quit, like spacing out cigarettes, smoking half cigarettes, changing their environment, ripping paper, playing games, and more. One participant said, "Figure out a system that's gonna work, something you know you are going to do, then add new stuff to that plan, and keep trucking along."

These accounts were in stark contrast to participants' descriptions of cannabis quit intentions, attempts, and outcomes. A few participants intended to quit cannabis but continued to use it to help with pregnancy-related symptoms. One participant said, "I attempted to stop, but I was always throwing up. So, I smoked [cannabis] to help nausea and for me to eat." Several other participants were ambivalent about stopping cannabis. Participant 1 said, "I didn't really try to stop [cannabis.] I just didn't think it was that bad." Some participants quit cannabis, but it seemed a low-effort endeavor, "I just gave it up because I wanted my baby to be healthy. I just dropped it one day out of nowhere." Some had a "better than safe than sorry" attitude, like Participant 9, who said, "I cut back a little bit more to be on the safe side, but there is no actual evidence that it is harmful while pregnant." Moreover, unlike tobacco, specific quit strategies were not discussed.

### ***Domain 3***

Domain three explored participants' accounts of cannabis-tobacco co-use. Most participants did not see a strong connection between their tobacco and cannabis use, and for

some, their cannabis and tobacco use were seen as fully distinct. For example, one participant said, “I use cannabis as a sleep aid. I use tobacco as an addiction. I view them individually, not together.” Another participant said, “I don’t really pay attention to mixing, that’s not important to me. I have a cigarette if I feel the need for a cigarette, and I smoke [cannabis] when I need to smoke, but they usually don’t go together.” Another participant mentioned different trajectories, explaining that she started using tobacco at a young age to manage ADHD and depression, but didn’t start cannabis until years later to manage chronic and severe pain. “My co-use really had nothing to do with each other.”

## **Discussion**

### **Integration**

The fourth aim was to integrate qualitative and quantitative findings to identify where findings converged, diverged, or were contradictory. Following the parallel convergent design, integration occurred after each data type was analyzed separately. Results were organized based on the aims, research questions, and hypotheses, summarized narratively and through a matrix approach to visually integrate data concisely. As presented in Table 14, a joint-display, side-by-side approach was used to illustrate how findings converged, diverged, or contradicted within each domain. Convergence indicated alignment between qualitative and quantitative findings, supporting similar conclusions. Divergence was noted when there were minor differences in the findings, while contradiction indicated direct opposition between qualitative and quantitative findings. Converging evidence increased confidence in the conclusions, while divergence and contradiction provided valuable insights, enriching the interpretation.

Throughout integration, qualitative and quantitative data held equal weight.

**Table 14.** Mixed Methods Matrix: Tobacco-Cannabis Co-Use Reasons, Behaviors, Experiences

<b>Research Question/Domain 1: Reasons birthing people use cannabis and tobacco during pregnancy</b>			
Quantitative Hypotheses	Key Quantitative Findings	Key Qualitative Findings	Relationship
H1: Birthing people will describe using cannabis and tobacco for different reasons.	Top reasons for tobacco use: stress relief, to manage mental health, habit/addiction.	Top reasons for both tobacco and cannabis use: manage stress and mental health.	Convergent: Mental health and stress were commonly reported reasons for both cannabis and tobacco use during pregnancy. Mental health and stress strongly influenced PCU in the qualitative study, however, the relationship was complex.
	Top reasons for cannabis use: feel calm/relaxed, stress relief, manage mental health, social reasons.  Hypothesis: Reject	Birthing people described a complex and nuanced relationship between substance use and mental health (cyclical, false need, doesn't fix deeper issues).	
H2: Birthing people who report using substances for mental health reasons will be more likely to continue to use substances during pregnancy compared to those who don't use substances to manage mental health.	Birthing people who reported using cannabis for <i>stress</i> were more likely to continue to use compared with people who didn't use cannabis to manage stress. The relationship did not persist after adjustment.		Diverge: Using cannabis to manage pregnancy-related symptoms was not among the top reasons reported in the quantitative portion. This was mentioned in the qualitative portion but was not a major theme.
	None of the other reasons predicted quit outcomes.  Hypothesis: Reject		

**Research Question/Domain 2: Quit intentions, attempts, and outcomes by substance**

Quantitative Hypotheses	Key Quantitative Findings	Key Qualitative Findings	Relationship
H1: There will be differences between quit intentions, attempts, and outcomes for both cannabis and tobacco.	Far more birthing people intended and attempted to quit tobacco than cannabis.	Many birthing people described an intense desire to quit tobacco. Many birthing people were ambivalent about quitting cannabis.	Convergent: While cannabis and tobacco quit intentions and attempts were very different, outcomes were similar.
	The quit rates were roughly the same for both substances.  Hypothesis: Not statistically significant, but still accept	Many birthing people described meticulous plans and difficulties when attempting to quit tobacco.	Divergent: Intentions and attempts did not strongly influence outcomes, but for different reasons. For tobacco, this was due to extreme difficulty with quitting. For cannabis, this was due to ambivalence.
H2: Birthing people who intend to quit will be more likely to report tobacco and cannabis quit attempts than birthing people who did not intend to quit.	Quit intentions did not influence quit attempts for either substance.  Hypothesis: Reject	Cannabis quit attempts were fewer and far between. Sometimes, attempts were prompted by a “better safe than sorry” feelings and/or pregnancy-related symptoms (cannabis making nausea worse).	
H3: Birthing people who intend to quit will be more likely to quit tobacco and cannabis than birthing people who did not intend to quit.	Quit intentions did not influence quit outcomes for either substance.  Hypothesis: Reject	Roughly the same number of birthing people described quitting tobacco and cannabis; however, the behavioral processes leading to that outcome differed greatly.	
H4: Birthing people who attempted to quit will be more likely to quit tobacco and cannabis than birthing people who did not attempt to quit.	Quit attempts did not influence quit attempts for either substance.  Hypothesis: Reject		

**Research Question/Domain 3: Quit intentions, attempts, and outcomes by CTCU category**

Quantitative Hypotheses	Key Quantitative Findings	Key Qualitative Findings	Relationship
<p>H1: There will be differences between quit intentions, attempts, and outcomes by co-use category.</p>	<p>There were differences in quit intentions, attempts, and outcomes by co-use category.</p> <p>Hypothesis: Not able to calculate statistical significance, but still accept</p>	<p>Birthing people did not see a strong connection between their tobacco and cannabis use.</p>	<p>Converge: While there were differences in quit intentions, attempts, and outcomes by co-use category, behavioral processes did not influence each other. Birthing people saw their use of both substances as mostly distinct.</p>
<p>H2: Birthing people who intend, attempt, and quit tobacco will be more likely to intend, attempt, and quit cannabis.</p>	<p>Tobacco quit intentions and attempts did not influence cannabis quit intentions or outcomes.</p> <p>In unadjusted models, quitting tobacco predicted quitting cannabis. This relationship did not persist after adjusting for mental health and intervention dose.</p> <p>Hypothesis: Reject</p>		

### ***Research Question/Domain 1***

Research question/domain one examined the reasons birthing people use cannabis and tobacco during pregnancy. The first hypothesis tested whether birthing people would describe using both substances to manage stress and mental health and whether birthing people would describe using cannabis to manage pregnancy-related symptoms like nausea and low appetite. The quantitative component of the study also tested whether birthing people who report using substances for mental health reasons would be more likely to continue to use substances during pregnancy compared to those who don't.

The qualitative and quantitative findings both converged and diverged. Mental health and stress were among the top reasons for use in the quantitative portion and the study and were one of the three major themes in the qualitative analysis. In the quantitative portion of the study, birthing people who reported using cannabis for stress were more likely to continue to use compared with people who didn't use cannabis to manage stress. However, this relationship did not persist after adjustment, and none of the other reasons predicted quit outcomes. Findings diverged when it came to using cannabis to manage pregnancy-related symptoms. While this reason was endorsed in the quantitative portion, it was not among the top reasons reported in the quantitative portion. Use of cannabis to manage pregnancy-related symptoms was mentioned in the qualitative portion of the study but was not a major theme.

### ***Research Question/Domain 2***

Research question/domain two quit intentions, attempts, and outcomes by each substance. The first hypothesis tested whether there were differences between quit intentions, attempts, and outcomes for both cannabis and tobacco. Although far more birthing people

intended and attempted to quit tobacco than cannabis, the overall quit outcomes were roughly the same for both substances. The Fisher's Exact test demonstrated that quit attempt and outcomes were significantly associated for tobacco ( $p=0.03$ ) but not for cannabis. In logistic regression models, attempts did not predict quit outcomes for tobacco or cannabis.

The next set of hypotheses tested whether birthing people who (1) intended to quit would be more likely to report tobacco and cannabis quit attempts than birthing people who did not intend to quit, (2) intended to quit would be more likely to quit tobacco and cannabis than birthing people who did not intend to quit, and (3) whether quit attempts influence quit outcomes. All three of these hypotheses were rejected.

In the qualitative portion, many birthing people described an intense desire to quit tobacco, yet birthing people were more ambivalent about quitting cannabis. Additionally, while many birthing people described meticulous plans and difficulties when attempting to quit tobacco, cannabis quit attempts were fewer and far between. Sometimes, attempts were prompted by "better safe than sorry" feelings and/or pregnancy-related symptoms (cannabis making nausea worse). In the end, roughly the same number of birthing people quit tobacco and cannabis despite very different paths to get there.

The quantitative and qualitative findings again both converged and diverged. While cannabis and tobacco quit intentions and attempts were very different, outcomes were similar. However, intentions and attempts did not strongly influence outcomes for different reasons. For tobacco, this was due to extreme difficulty with quitting, while for cannabis, this was due to ambivalence.

### ***Research Question/Domain 3***

The final research question/domain was to examine cannabis-tobacco co-use behaviors. The first hypothesis tested whether there would be differences in quit intentions, attempts, and outcomes by co-use category. While the cell sizes were too small to run statistical tests for this hypothesis, the differences were still meaningful, and thus, the hypothesis was accepted. The second hypothesis tested whether birthing people who intended to, attempted to, and quit tobacco will be more likely to intend to, attempt to, and quit cannabis. This hypothesis was rejected, as tobacco quit intentions and attempts did not influence cannabis quit intentions or outcomes. In unadjusted models, quitting tobacco predicted quitting cannabis. However, this relationship did not persist after adjusting for mental health and intervention dose.

In the qualitative portion of the study, birthing people did not see a strong connection between their tobacco and cannabis use. Thus, the qualitative and quantitative findings converged. While there were differences in quit intentions, attempts, and outcomes by co-use category, behavioral processes did not influence each other, and birthing people saw their use of both substances as mostly distinct.

### **Interpretation**

To the authors' knowledge, this study was the first to use mixed methods to understand prenatal tobacco-cannabis co-use. A major finding of this study was the use of CTCU to manage stress and mental health. The quantitative analysis revealed that many birthing people used tobacco and cannabis to manage their mental health and stress, and the qualitative analysis illuminated these findings, describing a complex and nuanced relationship.

Among the participants in this study, there were discrepancies between quit intentions, attempts, and outcomes. Among participants who intended to quit both substances, most attempted to quit both, but few were successful. On the other hand, among participants who intended to quit just one substance, about half attempted to quit both, and about a third quit both. Interestingly, among those who intended to continue using both substances, most ended up making quit attempts. While quit attempt and outcomes were associated for tobacco, there was no difference when it came to cannabis. This points to further discrepancies between what pregnant people say their intentions are and actual behavior change during pregnancy.

The way “intent” and “attempt” were measured in this study (yes/no) may have limited the ability to understand their role in PCU behavior change. Future studies should consider different ways to measure the complexities of quit attempts, such as the “number of series quit attempts” or the level of effort exerted in the quit attempt. It could also be that intent and attempts to quit are not as important as factors when examining substance use behaviors in marginalized populations with complex needs. This aligns with other evidence indicating that the link between intentions and behavior is weaker than previously believed.<sup>133,134</sup> While assessing pregnant people’s intentions around their substance use is still important, intentions may not always translate to actual behavior changes like quit attempts and outcomes. Thus, ongoing, tailored support throughout the prenatal period is important.

The interview data illuminated these findings, describing the struggles participants faced. Participants described a strong desire to quit tobacco and detailed and meticulous plans to quit. Many also expressed frustration and hopelessness in their struggles to quit tobacco, citing withdrawal symptoms and strong cravings. This contrasted with cannabis use, where

participants expressed mixed intentions and ambivalence about quitting. Very few described strategies to quit cannabis, and quitting cannabis generally required less effort.

In non-pregnant adults, multiple mechanisms for co-use have been suggested. Some of these theories include the “synergism effect” (use of one substance to enhance or stimulate the effects of the other,) the “addiction vulnerability hypothesis” (shared genetic predisposition toward the use of both substances), and the “gateway” and “reverse gateway theories” (use of one substance primes people to use the other).<sup>163</sup> There is also some evidence suggesting that using one substance alleviates the adverse effects of the other.<sup>163</sup> While a small minority of participants in this study described their co-use in ways that align with these theories, most participants viewed their use of cannabis and tobacco mostly as distinct and separate. These results were also seen in the quantitative data. After adjusting for demographics and intervention dose, the association between participants' tobacco and cannabis quit statuses was no longer significant.

### **Implications**

These findings have implications for public health, healthcare, and policymakers. The connections between mental health, stress, and substance use are a key finding. Research involving adolescent cannabis users has provided insight into the intersections between cannabis use and mental and behavioral health conditions, suggesting shared biological mechanisms, heritability factors, and overlapping neurocircuitry features.<sup>174</sup> The present study reinforces the need to better understand these complex and interrelated conditions, especially during vulnerable time periods like pregnancy.

Participants in this study described deeply nuanced and conflicting feelings about their use of cannabis to manage mental health and stress. These findings could indicate that tobacco and cannabis use are the “canary in the coal mine,” pointing to deeper unmet mental health needs. This aligns with other research demonstrating a higher prevalence of unmet mental health treatment needs among people who use cannabis.<sup>175</sup>

While cannabis and tobacco screening are an essential part of quality prenatal care, there are significant barriers to implementation and ethical concerns, particularly for pregnant individuals who use cannabis. Research indicates that between one- and two-thirds of pregnant individuals do not disclose cannabis use to their prenatal care providers, often due to fear of CPS reports and judgment.<sup>84,102</sup> Those who do disclose report receiving inconsistent, punitive, and largely unhelpful information. A study by Holland et al. found that 23% of providers made no acknowledgment of cannabis use disclosures, and 48% offered no specific counseling. Among those who did provide counseling, 70% of the discussion focused on legal implications and CPS investigations.<sup>75</sup> Furthermore, racial bias has been well-documented in prenatal cannabis use screening, biochemical testing, reporting, and counseling.<sup>75,158</sup> Institution- and provider-level accountability measures and policies that address and correct racial inequities are urgently needed.

The wide variation in CTCU use patterns and the challenges reported by participants suggest the need for tailored, trauma-informed, and person- and context-centered approaches. Most participants attempted to quit both cannabis and tobacco. Evidence-based tools and practices such as Screening, Brief Intervention, and Referral to Treatment (SBIRT), Motivational

Interviewing, and Contingency Management have been used to increase treatment adherence and outcomes among pregnant tobacco users.<sup>109,157</sup>

Whether these practices increase treatment adherence and outcomes among pregnant co-users and cannabis-only users is not well understood. Some studies have shown no impact of cannabis use on tobacco outcomes; others show that cannabis use is associated with poor tobacco cessation outcomes.<sup>163</sup> For example, in one study of non-pregnant adults, 50% of co-users increased their cannabis use during tobacco cessation attempts, and 62% increased their tobacco use when trying to quit cannabis.<sup>176</sup> A longitudinal study examining patterns of co-use among pregnant people found that about half transitioned to tobacco use only during pregnancy.<sup>177</sup> In most of these studies, however, variations in cannabis use (dose, administration method, frequency of use) are typically not taken into consideration, which is a major limitation. Standard definitions of co-use are an important consideration in future studies. Newer research suggests that co-use definitions go beyond timing and examine concepts of co-use intent and motivations.<sup>178</sup>

These strategies are unlikely to significantly impact progress unless state and federal policies, statutes, and reporting requirements are updated. Punitive policies have been associated with poorer perinatal outcomes.<sup>169,179</sup> States should (1) eliminate substance use as grounds for child abuse or civil commitment, (2) remove mandatory reporting requirements for substance use, (3) prioritize access to treatment programs for pregnant individuals, and (4) prohibit discrimination against pregnant individuals who use substances in state statutes.

## **Limitations and Strengths**

This study had some limitations. First, the sample size was small, which limited the ability to conduct certain analyses and increased the risk of Type I and II errors. While most participants smoked cannabis and tobacco, a fair number also reported vaping and using edibles. Thus, future research should investigate differences in CTCU by administration modalities. The administration mode is also important for determining exposure to other toxicants like carbon monoxide and lead, which are known to adversely impact infant health.<sup>30</sup> In addition to the administration method, future research should also focus on the frequency and dose of tobacco and cannabis use, particularly when examining the impact of CTCU on maternal and infant health outcomes. Future research should also address pregnant people's use of cannabinoid hemp products, like Delta-8-tetrahydrocannabinol. While this study's sample size was too small to examine cut-down patterns, future CTCU studies should utilize a harm-reduction approach. Future research should also examine other co-use and polysubstance use patterns, particularly patterns involving alcohol, a known teratogen.<sup>48</sup>

This study used secondary data from pregnant people who participated in a voluntary program and, therefore, potentially had more access to information, support, and resources than other pregnant cannabis users. At the time of this study, adult recreational use of cannabis was restricted in Wisconsin. While this study used only secondary, de-identified data collected within the safety of a harm reduction program to protect participants, it is possible that participants withheld information as a self-protection measure.

This study also had several key strengths. Mixed methods, particularly the use of convergent parallel design and Synthesized Member Checking (SMC) increased the

trustworthiness of findings. RTA allowed for a systemic and flexible approach to a unique dataset and a protected population. Social desirability bias has been noted as a limitation in previous substance use literature but was minimized in this study as all data were collected within the safety of a therapeutic relationship. Rapport building, careful interview design, and word choice were all used to further reduce social desirability bias.<sup>139,140</sup> Finally, this study used data from an existing community-based program, leading to high ecological validity. In assessing the transferability of findings, care must be taken not to use this study to make broader assumptions about CTCU. The local setting and socio-political context were important factors in interpreting the results.

### **Conclusion**

Cannabis-tobacco co-use in prenatal populations is complicated. Although participants in this study achieved similar quit rates for both substances, there were stark differences in quit intentions and attempts. The use of substances to manage mental health and stress was a key finding that arose from both the quantitative and qualitative strands of this study. The results of this study may be used to develop effective, appropriate, non-punitive prenatal cannabis prevention, intervention, and policy efforts that protect and promote the health of pregnant people, infants, and children.

## Chapter 5. Conclusion

### Integration

The fourth aim of this dissertation was to identify the most salient influences on prenatal cannabis use (PCU) by systematically integrating qualitative and quantitative findings. This integration occurred after qualitative and quantitative data were analyzed separately in line with the parallel convergent design. Results were organized using the domains identified in the a priori conceptual model. Results were then summarized in narrative form and using a matrix technique, a method used to visualize the concise integration of quantitative and qualitative data.<sup>97</sup> As shown in Table 15, the matrix provided a snapshot of the key ways the findings converged, diverged, or contradicted each other within each domain.<sup>99</sup> Convergence was noted when qualitative and quantitative data findings aligned and supported similar conclusions. Divergence occurred when there were minor differences or variations in the findings, while contradiction was noted when the qualitative and quantitative findings directly opposed one another. While evidence of convergence strengthened confidence in the findings, occurrences of divergence and contradiction served an equally important role, leading to a more nuanced explanation of the findings and a more refined, final conceptual model.<sup>98,99,180</sup> Throughout the integration process, qualitative and quantitative data were weighted equally.

**Table 15.** Mixed Methods Matrix of Multidimensional Influences on PCU

<b>Domain 1: Demographic</b>			
Factors Examined	Key Findings – Quantitative	Key Findings - Qualitative	Relationship
Relationship status	Relationship status was not associated with PCU.	Relationship status alone was not identified as a theme.	Converge: Not influential
Race/ethnicity	Racial/ethnic identity was not associated with PCU.	Racial/ethnic identity was not identified as a theme.	Converge: Not influential
Age	Age was not associated with PCU.	Age was not identified as a theme. However, some participants discussed pregnancy timing as a stressor, which in turn impacted PCU.	Converge: Not influential
Income	Income was not associated with PCU.	Income was not identified as a theme. However, some participants discussed financial insecurity as a stressor, which in turn impacted PCU.	Converge: Not influential
Education	Education was not associated with PCU.	Education was not identified as a theme.	Converge: Not influential
Employment	Employment status was not associated with PCU.	Employment status was not identified as a theme.	Converge: Not influential
<b>Domain 2: Cognitive</b>			
Factors Examined	Key Findings – Quantitative	Key Findings - Qualitative	Relationship
Reasons for use	The most common reasons for PCU were to: “feel calm, relaxed, or level,” “relief from stress,” “manage mental health symptoms,” and for “social reasons.” While the endorsement of these reasons did not predict cannabis amount, the frequency in which they were reported was an important finding.	The use of cannabis to manage mental health and stress were identified as the top reasons for use in both qualitative and quantitative analyses.	Converge: Top reasons for use were nearly identical in qualitative and quantitative analyses. While not predictive of PCUF, reasons were a key factor in the decision-making process

Quit intentions	Birthing people who intended to cut down had higher rates of PCUF than those who did not, however, the relationship did not persist after adjusting for other influences and time.	Birthing people expressed wide variations in their intentions to quit. Intentions did not always result in behavior change.	Convergent: The intention-behavior connection was present but not a strong influence on PCU.
Quit attempts	Quit attempts were not associated with PCU.	Birthing people expressed wide variations in their quit attempts. Attempts did not always result in behavior change.	Convergent: Quit attempts were not a strong influence on PCU.
<b>Domain 3: Psychological</b>			
Factors Examined	Key Findings – Quantitative	Key Findings - Qualitative	Relationship
Mental health	Mental health condition alone was not associated with PCU.	The relationship between mental health conditions and PCU was a main theme. Multiple mental health conditions were discussed, including anxiety, depression, ADHD, bipolar disorder, and post-traumatic stress syndrome (PTSD), and PCU was identified as a major theme.	Contradictory: The relationship between mental health and PCU was not evident in the quantitative analysis but was a major qualitative finding.
Anxiety	Participants who reported mild anxiety used cannabis at nearly twice the rate of those who reported minimal anxiety, however, in some models, participants who reported moderate to severe anxiety used cannabis at lower rates than those who reported minimal anxiety. However, the relationship between anxiety and PCUF did not remain significant in the full models.	The relationship between mental health conditions, including anxiety, and PCU was a main theme.	The relationship between mental health and PCU is complex.

Depression	Depression severity was not associated with PCU.	The relationship between mental health conditions, including depression, and PCU was a main theme.	
Stress	Stress level was not associated with PCU. Using cannabis to manage stress was not associated with PCU.	Use of cannabis to manage stress was a major theme. Birthing people described complex and nuanced nature of the relationship between stress and PCU.	Contradictory: The relationship between stress and PCU was not evident in the quantitative analysis but was a major qualitative finding.
<b>Domain 4: Social</b>			
<b>Factors Examined</b>	<b>Key Findings – Quantitative</b>	<b>Key Findings - Qualitative</b>	<b>Relationship</b>
Social support	Level of social support was not associated with PCU.	General social support was not identified as an influence on PCU.	Converge: Not influential
Social network influence	<p>Birthing people who reported that “all/most” of the people in their social network used cannabis used cannabis themselves at more than twice the rate as those who reported “few or no” cannabis users in their social network. This relationship remained significant in both fully adjusted and time-interaction adjusted models.</p> <p>Birthing people who reported that “most or all” or “some” of the people in their social circle were less likely to have a downward trend in PCUF over the prenatal period</p>	Social influences on PCU was a major theme. Partners influenced PCU influenced current use in both directions: use less or use more cannabis. Friends influenced both cannabis initiation and PCU. Family influenced cannabis initiation but were mentioned less when it came to cannabis use during pregnancy.	Converge: Social influences strongly influenced PCU

Household cannabis rules	<p>In quantitative analysis, pregnant people who lived in households where cannabis smoking was allowed used cannabis at nearly 2.5 times the rate as those who reported that cannabis was non-allowed. This relationship remained significant in adjusted models and time-interaction models.</p> <p>Birthing people who resided in households where cannabis was allowed were less likely to have a downward trend in PCUF over the prenatal period.</p>	Household cannabis rules were mentioned as part of broader discussions around partner influences. Several participants mentioned changes to household cannabis rules during pregnancy.	Diverge: Household cannabis rules impacted PCU in the quantitative analysis but were not a major theme in the qualitative analysis.
<b>Domain 5: Substance use</b>			
Factors Examined	Key Findings – Quantitative	Key Findings - Qualitative	Relationship
Initiation	Initiation age was not associated with PCU.	Initiation was not a central theme but was a key factor in birthing people’s overall cannabis use trajectory, the effects of which persisted into pregnancy. Many birthing people described initiating cannabis during adolescence to handle difficult situations, trauma, and social pressures and to manage mental health symptoms.	Converge: Initiation was not directly influential but part of the overall CU trajectory.
Duration	Not associated with PCU	Duration was not a central theme. However, some participants described duration as a barrier to reducing cannabis use during pregnancy.	Converge: Duration was not directly influential but part of the overall CU trajectory.

Preconception Use	<p>Birthing people who reported daily cannabis use during preconception used cannabis during pregnancy at more than five times the rate of those who reported less than weekly preconception use. This relationship remained significant in the fully adjusted model and time-interaction models.</p> <p>Birthing people who reported daily or weekly preconception cannabis use were less likely to have a downward trend in PCUF over the prenatal period.</p>	<p>Preconception use was not a major theme. However, some mentioned it as a barrier to quitting due to the perceived benefits of use.</p>	<p>Diverge: Quantitatively, preconception use was strongly associated with PCU. Qualitatively, preconception use was not directly influential but part of the overall CU trajectory.</p>
Tobacco co-use	<p>Birthing people who were light/intermittent and regular tobacco users used cannabis at more than double the rate of people who used no tobacco. This relationship remained significant in fully adjusted and time-interaction models.</p> <p>Birthing people who were regular or light/intermittent smokers were less likely to have a downward trend in PCUF over the prenatal period.</p>	<p>Tobacco use was not a major theme. A few birthing people described tobacco as a barrier or facilitator to quit cannabis. However, most birthing people felt their tobacco and cannabis use were largely independent of one another.</p>	<p>Diverge: Quantitatively, tobacco co-use was strongly associated with PCU. Qualitatively, co-use was not directly influential on PCU.</p>

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**Domain 6: Structural**

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Factors Examined	Key Findings – Quantitative	Key Findings - Qualitative	Relationship
Commercial influences	Not examined	While not directly influential on PCU, birthing people described a rapidly changing cannabis industry. Some expressed frustration with the lack of regulatory action and product placement (especially in gas stations).	N/A
Social norms	Not examined	While not directly influential on PCU, most birthing people describe an increasingly high level of social acceptability for cannabis use.	N/A
Stigma	Not examined	While not directly influential on PCU, some birthing people described negative experiences, stigma, and discrimination from prenatal healthcare providers.	N/A
Policy influences	Not examined	Birthing people described frustration with punitive policies but did not indicate that these policies influenced their use.	N/A

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### **Domain 1: Demographic Factors**

Both quantitative and qualitative analyses demonstrated that demographic factors did not influence PCU, thus, the findings converged. However, going beyond surface-level demographic factors revealed important findings better captured in other domains. For example, relationship status was not associated with PCU in quantitative analyses; however, the influence of partners on PCU was a key theme identified in the qualitative analyses. Similarly, income was not associated with PCU in the quantitative analysis, but in interviews, financial insecurity was described as a stressor that impacted PCU in interviews.

### **Domain 2: Cognitive Factors**

In both quantitative and qualitative analyses, reasons for cannabis use were examined. In the quantitative studies, the most reported reasons for cannabis use during pregnancy were to “feel calm, relaxed, or level,” get “relief from stress,” “manage mental health symptoms,” and for “social reasons.” While the endorsement of these reasons did not predict the amount of cannabis used, the frequency with which these reasons were reported was an important finding. In qualitative analyses, some birthing people described using cannabis to manage pregnancy-related conditions (nausea, vomiting, appetite, pain, and sleep); however, far more reported the use of cannabis to manage stress and mental and behavioral health conditions, most notably anxiety, ADHD, and depression. Their descriptions of these relationships were bi-directional. For some, these experiences led to increased use of cannabis, and for others, it facilitated cannabis discontinuation.

Birthing people’s intention to quit was another cognitive factor examined. In quantitative analyses, birthing people who intended to cut down had higher rates of PCUF than

those who did not; however, the relationship did not persist after adjusting for other influences. In qualitative interviews, birthing people expressed varied intentions to quit. While some felt strongly about quitting and others felt strongly about continuing to use, most fell somewhere in between, expressing ambivalence or uncertainty. Further, intentions and attempts to quit did not always result in behavior change. So, while the intention-behavior connection was present, it was not identified as a significant influence on PCU.

### **Domain 3: Psychological Factors**

Findings regarding the psychological influences on PCU were complex. In quantitative analyses, having a mental health condition on its own did not predict PCU; however, examining anxiety severity led to surprising results. In the time-interaction model adjusting for psychological variables, participants who reported mild anxiety used cannabis at nearly twice the rate of those who reported minimal anxiety. However, in some models, participants who reported moderate to severe anxiety used cannabis at *lower* rates than those who reported minimal anxiety. While these relationships did not remain significant in time-adjusted models, many participants discussed strong connections between anxiety and cannabis use in the qualitative portion of the study. Similarly, while the quantitative analyses did not demonstrate a relationship between depression and PCU, the relationship between cannabis use and depression was discussed in detail in the qualitative interviews. Thus, the findings here were contradictory, affirming the complex and multi-layered nature of the mental health-cannabis relationship.

When it came to stress, the findings were contradictory. Although stress was identified as a significant reason for use in the quantitative analyses, it was not associated with increased

PCU. However, in qualitative studies, stress emerged as a significant influence on PCU. During pregnancy, some participants used cannabis for antecedent-focused emotional regulation, managing stress about future events. However, it was more commonly used for down-regulation, with some describing cannabis as a grounding practice or a way to achieve mental clarity. The discrepancy between the qualitative and quantitative findings could be due to how stress was measured (high, medium, low). Using validated stress tools could have revealed important differences in PCUF patterns.

#### **Domain 4: Social Factors**

Qualitative and quantitative findings around the social influences on PCU were consistent and convergent. In quantitative analyses, pregnant people who lived in households where cannabis smoking was allowed used cannabis at nearly two and a half times the rate as those who reported that cannabis was non-allowed. Similarly, pregnant people noted that “all or most” of the people in their social network used cannabis themselves at more than twice the rate as those who reported “few or no” cannabis users in their social network. These relationships remained significant in both fully adjusted and time-interaction adjusted models. Group-level differences in prenatal cannabis use patterns over the prenatal period were also noted. Birthing people who reported that “most or all” or “some” of the people in their social circle used cannabis were less likely to have a downward trend in PCUF over the prenatal period. Additionally, those who resided in households where cannabis was allowed had higher PCUF overall, and a slight upward trend in PCUF over the prenatal period was noted.

In qualitative analyses, family and friends influenced cannabis initiation, early use, and preconception use. During pregnancy, partners influence birthing people’s current use, and a

bidirectional relationship was noted. For some, their partners' use of cannabis influenced them to continue using cannabis during pregnancy. While others said their partners influenced them to use less cannabis or to fully discontinue their use.

### **Domain 5: Substance Use Factors**

Multiple substance use factors were examined. In quantitative analyses, cannabis initiation age was not associated with PCU. In the qualitative portion of the study, initiation was not a central theme, but it was a critical factor in birthing people's overall cannabis use trajectory, the effects of which persisted into pregnancy. Many birthing people described initiating cannabis during adolescence to handle difficult situations, trauma, and social pressures and to manage mental health symptoms. Similarly, results around duration - or years of cannabis use – converged. Duration did not influence PCU in quantitative analyses, nor was it identified as a central theme in qualitative interviews. However, some participants described duration as a barrier to reducing cannabis use during pregnancy.

Preconception use was identified as a significant influence on PCU in quantitative analyses but was not a major theme in the qualitative component of the study; thus, the findings diverged. In quantitative analyses, participants who reported daily cannabis use during preconception used cannabis during pregnancy at more than five times the rate of those who reported less than weekly preconception use. This relationship remained significant in the fully adjusted model and time-interaction models. Differences in PCU patterns over the prenatal period were also noted. Daily and weekly preconception users were less likely to have a downward trend in PCUF over the prenatal period. In fact, weekly users exhibited a slight

upward trend across all three time points. Qualitatively, preconception use was not directly influential but was part of people’s overall cannabis use trajectory.

Similarly, the findings around the role of tobacco co-use on cannabis diverged. In quantitative analyses, pregnant people who were light or intermittent tobacco users (less than five cigarettes per day) and regular tobacco users (six or more cigarettes per day) used cannabis at more than double the rate of people who used no tobacco. This relationship remained significant in fully adjusted and time-interaction models. When examining trends over the prenatal period, regular and light/intermittent smokers were less likely to exhibit a downward trend in PCUF over the prenatal period. In qualitative analyses, co-tobacco use was discussed in terms of barriers to quitting, but co-use use was not identified as a central theme. Many birthing people felt their tobacco and cannabis use were largely independent of one another.

### **Domain 6: Structural Factors**

Structural influences on PCU were only examined in the qualitative analyses. Birthing people discussed and described structural factors as “systems failures” rather than directly influencing their cannabis use. Birthing people described a rapidly changing cannabis industry, and some expressed frustration with the lack of regulatory action and product placement of cannabinoid hemp products, especially in gas stations. Most birthing people described an increasingly high level of social acceptability for cannabis use; however, again, this did not seem to impact their use. Some birthing people described negative experiences, stigma, and discrimination from prenatal healthcare providers. Finally, birthing people expressed frustration with punitive policies; however, like other structural factors, there was not much indication that these policies influenced their use during pregnancy.

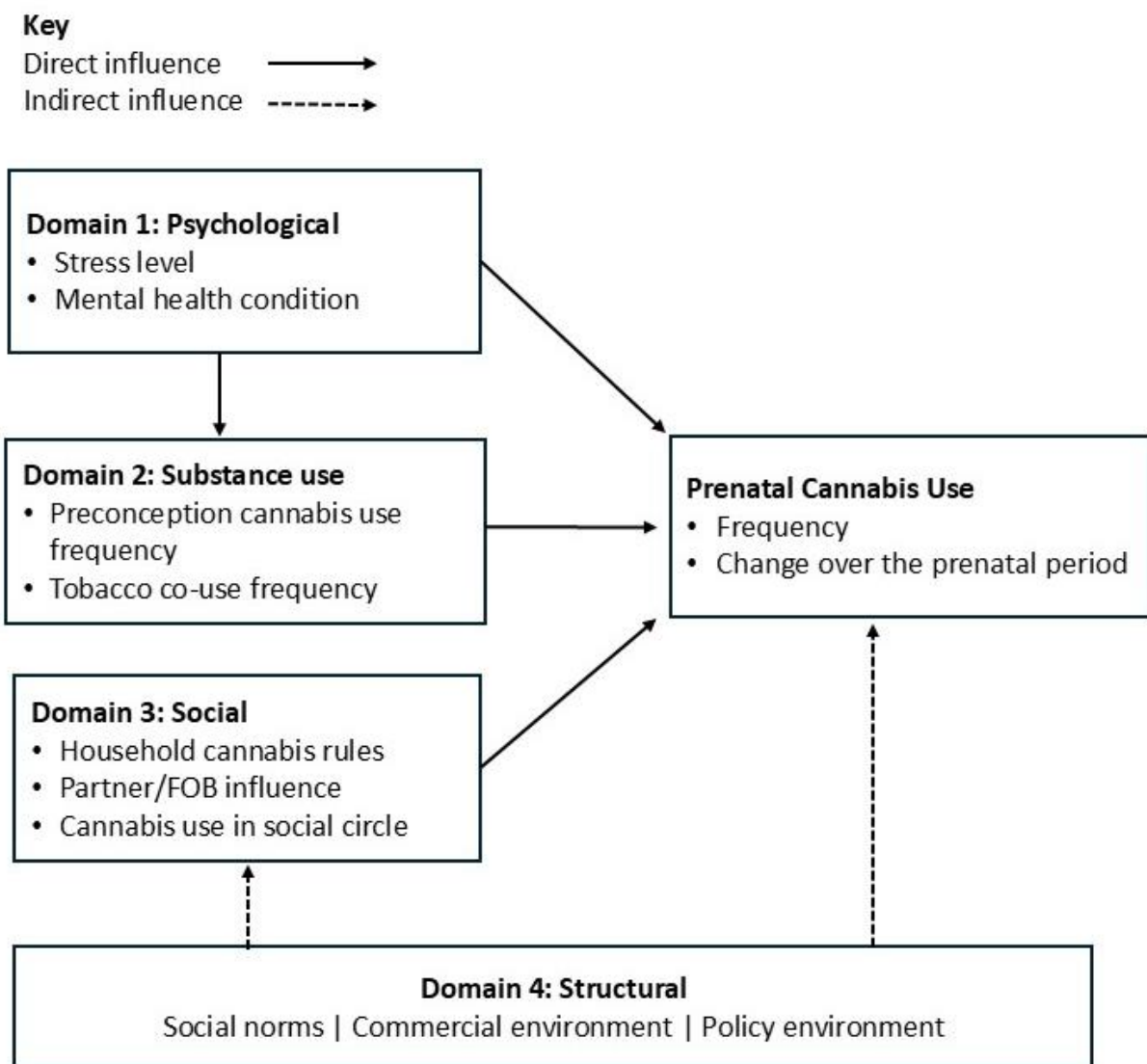
## Final Conceptual Framework

The final aim of this dissertation was to assemble a final conceptual framework based on the study's findings. As described in Chapter One, an a priori conceptual model was constructed to illustrate the most salient factors influencing prenatal cannabis use. This model included 33 factors organized within six domains. This dissertation used mixed methods to examine these factors in a deeper, more nuanced, and contextualized way. The findings were used to update the final conceptual model. Factors that did not influence PCU in qualitative or quantitative analyses were removed entirely from the model. Factors significant in qualitative *or* quantitative findings were kept in the model if they met one of two criteria. First, factors that were significant in the quantitative analyses but not qualitative were included if they remained significant after controlling for confounders. Second, factors not significant in the quantitative analyses but identified as influential in qualitative findings remained in the model only if the relationship supported a major theme. Five important changes were made to the model with these parameters described below and illustrated in Figure 12.

The first major finding was that no demographic factors predicted PCU directly, starkly contrasting previous PCU literature. Some of these factors indirectly affected PCU; for example, financial insecurity led to stress, which influenced PCU. However, these influences were not major findings, so demographics were removed entirely from the model. Second, the early connections between mental health and cannabis use trajectory were an important finding. So, an arrow was added to illustrate this relationship in the new model. Fourth, most cognitive factors were not identified as major influences on PCU. Importantly, “intention” – a key construct in IBM was not influential on PCU in this study and was removed from the framework.

Reasons for use influenced PCU, however, the top reasons for use were more aligned with the psychological domain. As such, the cognitive domain was entirely removed. Finally, while structural influences were important for contextual information, they did not directly influence PCU. They remain in the model for contextual reasons, but the “direct influence” lines were removed and replaced with dotted lines to represent an indirect influence.

**Figure 12.** Final Conceptual Model: Multidimensional Influences on PCU



## **Discussion**

Four key factors were identified as the most influential on prenatal cannabis use: (1) mental health, (2) social influences, (3) preconception use, and 4) tobacco co-use. A detailed discussion of these factors is essential for understanding the broader implications and connections to existing literature.

### **Mental Health**

Birthing people in this study described a complex relationship between mental health and cannabis use, including various forms of emotional regulation, grounding, relief from mental health symptoms, and avoiding the side effects of conventional medications. Previous PCU literature that examined the cannabis-mental health relationship often concluded that birthing people should be ushered into “safer” or more “conventional” mental health treatment. However, that oversimplifies the issue on multiple levels. In a Journal of the American Medical Association (JAMA) commentary on this topic, Takakuwa et al. remind us that even “conventional treatments,” specifically some commonly used licit medications, are also not fully studied, and their safety during pregnancy is not assured.<sup>35</sup> Rather than focus on “safer” treatment, it is critical to zoom out and recognize that for many pregnant people, mental health care is not accessible, culturally appropriate, or affordable.<sup>152</sup> Over 60% of pregnant and postpartum people with mental health conditions do not receive mental health services.<sup>153</sup> This study affirms that accessible, integrated mental health and substance use interventions are urgently needed. Promising approaches have been noted; for example, one study found that a referral to a perinatal mental health specialist in the first trimester was associated with increased cannabis cessation.<sup>155</sup> A systematic review of integrated substance

use and mental health interventions identified a wide range of psychoeducation and psychological approaches; however, few were rigorously evaluated.<sup>154</sup> Substance use and mental health care are currently siloed, resulting in fragmented care.<sup>154</sup> Thus, integrating care will require innovation and complex, system-level changes.

It is also critical to contextualize these findings. Participants in this study described using cannabis to deal with extremely difficult circumstances or life-altering events occurring before and during pregnancy. Only a few other PCU studies have sought to contextualize cannabis use in this way. For example, a study of Aboriginal and Torres Strait Islander families also identified links between PCU, mental health distress, and stressful life events.<sup>181</sup> The Aboriginal authors and the Aboriginal Governance Group that led this study interpreted these findings within the broader context of adversity these communities face. They proposed that cannabis use might serve as a coping mechanism for complex mental health challenges stemming from colonization and intergenerational trauma, such as the loss of language, cultural traditions, and ancestral land.<sup>181</sup> Participants in this study describe extremely challenging circumstances before and during pregnancy, including trauma, sexual violence, housing insecurity, financial insecurity, and relationship changes. Additionally, this study was conducted in Wisconsin, a state that has among the most punitive prenatal substance use policies in the nation,<sup>73</sup> and among the highest rates of racial disparities in cannabis arrests.<sup>67</sup>

### **Social Influences**

While mental health was by far the most influential on participants' cannabis use, the role of social influence was notable. Social influences began well before pregnancy, with many participants describing how their peers, parents, and siblings impacted their use early on.

During pregnancy, participants were influenced more by their partners and the baby's fathers. For some, this led to more cannabis use and for others, the people in their lives influenced them to use less. Others felt that changes to their cannabis impacted their relationship. Nearly all participants felt that cannabis was mostly socially acceptable, in both social circles and in their communities.

Most of the current PCU literature relies solely on marital status, which doesn't capture the full range and complexity of partnerships, nor the influence of these relationships on PCU. When it came to partner influences in this study, there was a bidirectional relationship on PCU. For some, their partners influenced them to use more cannabis, and for others, their partners influenced them to use less. Furthermore, focusing exclusively on marital status partnerships overlooks the broader social networks that may impact birthing individuals, including relationships with parents, siblings, friends, and co-parents.

Additionally, pregnancy is a dynamic time, and social influences can change and shift during major life transitions. Similar patterns have been observed during other major life transitions, such as the shift from adolescence to young adulthood. For example, a recently published ten-year longitudinal study examining cannabis use over this period found that parental influence was significant during adolescence, but this effect diminished in adulthood. In contrast, peer influence remained a significant factor throughout the life course trajectory. These findings underscore the potential long-term staying power and the evolution of social influences on substance use behaviors.<sup>182</sup>

Studies have reported similar findings examining the transition from pregnancy to the postpartum period and parenthood. For instance, a cohort study of Aboriginal and Torres Strait

Islander families revealed that individuals who used cannabis during pregnancy experienced elevated levels of psychological distress, depression, and anxiety not only during the postpartum period but also when their children were between the ages of five and nine. These results highlight the persistence of mental health challenges among birthing individuals who engage in prenatal cannabis use, extending well into the later stages of parenting.<sup>181</sup>

While this study attempted to use more expansive measures to examine social influences on PCU, these two measures used (social circle cannabis use and household cannabis rules) only scratched the surface. As family structures and our understanding of the important role of social connections in health continue to evolve, research and interventions involving birthing individuals must better account for these changes.

### **Preconception Cannabis Use**

A primary influence on prenatal cannabis use was preconception cannabis use frequency. This finding aligns with other research in this area. For example, PRAMS data from nearly 14,000 pregnant people found that preconception cannabis use (PCCU) was associated with significantly more likely to report PCU depending on the states' legalization status.<sup>13</sup> People who reported PCCU were also up to five times more likely to report depression, tobacco, alcohol use<sup>183</sup> and twice as likely to report that their most recent pregnancy was not intended<sup>183</sup> compared with people who didn't use cannabis pre-pregnancy. Concerningly, 78% of preconception cannabis users reported knowing "little or nothing" about the effects of cannabis on the pregnant person or the fetus.<sup>87</sup> Taken together, the findings strongly support a lifecourse approach to addressing perinatal cannabis use, with efforts occurring well before pregnancy occurs.

While not examined in this study, future research, and public health efforts should also examine the impacts of cannabis beyond pregnancy. Postpartum cannabis use remains an understudied area, warranting further research. Although existing studies have shown that THC is transferred and accumulates in breast milk,<sup>184</sup> more studies are necessary to clarify the potential effects of maternal cannabis use on infant health outcomes.

Additionally, public health practitioners, policymakers, and researchers should examine the direct and indirect impacts of cannabis exposure on child development and well-being.<sup>185</sup> An estimated 8 million children in the U.S. live with a parent who uses cannabis. This highlights the need for comprehensive studies to examine both the direct and indirect impacts of cannabis exposure on child development and well-being.<sup>185</sup> Infants and children can be exposed to cannabis smoke (secondhand and thirdhand) and the aerosols produced by vaporized cannabis products. One study comparing cannabis and combustible cigarette smoke found that ammonia levels in cannabis smoke were found to be up to 20 times higher than in tobacco smoke.<sup>29</sup> Additionally, harmful chemicals like hydrogen cyanide, nitrogen oxides, and certain aromatic amines were found in cannabis smoke at concentrations up to five times higher rates than in tobacco smoke.<sup>29</sup> Accidental poisonings, especially as the cannabis product market continues to grow, are another area for research and public health intervention.<sup>186</sup>

### **Tobacco Co-use**

Tobacco co-use emerged as another significant influence on PCUF patterns over the prenatal period. Among past month prenatal cannabis users, 60% also used tobacco, 40% also used alcohol, and 17% used illicit substances.<sup>5</sup> While any co-substance use was associated with PCU,<sup>2</sup> the literature demonstrated a strong and consistent association between tobacco use

and higher rates of PCU in general,<sup>2,5,47,48,52,54</sup> higher rates of continued use,<sup>12,62</sup> and greater frequency of use.<sup>50</sup> This study adds to this growing body of evidence, demonstrating differences in PCUF trends based on the level of tobacco use and important differences in co-use quit intentions, attempts, and outcomes.

While there have been a few studies examining the effects of cannabis tobacco co-use on maternal and child health outcomes,<sup>64,65,177,187</sup> research on the co-use of cannabis with other substances is minimal. Alcohol, for example, is a known teratogen, and fetal exposure is associated with a host of adverse birth outcomes and a range of serious, permanent physical, cognitive, and behavioral outcomes.<sup>188</sup> Preclinical research shows that co-exposure to cannabinoids and alcohol increases the likelihood of birth defects involving the face and brain,<sup>189</sup> however, clinical studies examining the interaction between alcohol and cannabis use during pregnancy remain scarce.

In addition to understanding the impacts of co-use on maternal and child health outcomes, research should also be carried out to (1) develop and validate poly-substance use screening tools and (2) interventions that address multiple substances during pregnancy. This study and others that examined co-use behaviors demonstrate how complex these behaviors are.<sup>163</sup> While some studies indicate that cannabis use does not impact tobacco, while others indicate clear associations between cannabis use and poorer tobacco cessation outcomes.<sup>176</sup> For example, a longitudinal study of pregnant co-users revealed that approximately half shifted to using only tobacco during pregnancy.<sup>177</sup> However, like most other PCU research, these studies oversimplified their measurement of PCU. Future research on co-use should prioritize measurement that captures frequency, timing, and administration modes. Precise definitions of

co-use should also be used. A study by Bunting et al. drew from multiple disciplines to propose a recommended definition of co-use, which includes three key concepts: (1) substances used, (2) timing (simultaneous, sequential, and same-day use), and (3) intent.<sup>178</sup> These variables are important as previous research has noted differences in health outcomes based on co-use type.<sup>190</sup>

## **Implications**

The American College of Obstetricians and Gynecologists, American Academy of Pediatrics, American Society of Addiction Medicine, and the U.S. Surgeon General all advise pregnant people to abstain from cannabis.<sup>118,119,141,142</sup> However, efforts have fallen short. Public health infrastructure is needed to better address cannabis in various activities, including public education, monitoring, surveillance, assessing population-level impacts of industry and policy changes, and racial and social equity efforts. Specifically, the findings from this study carry essential implications across several domains, including (1) improving the measurement of prenatal cannabis use, (2) expanding access to information, (3) promoting equitable clinical and community interventions, (4) establishing cross-sector collaborations, (5) informing policy changes, and (6) prioritizing participatory approaches.

## **Improving Prenatal Cannabis Use Measurement**

This study's findings highlight the complexity and dynamic nature of prenatal cannabis use (PCU) behaviors. Cannabis use in the second and third trimesters differed significantly from the first, and PCU trajectories varied according to multiple predictor variables. Factors such as frequency of use and time-sensitive effects played crucial roles in identifying the most influential factors on PCU. However, much of the existing PCU literature relies on broad, binary

measures like “ever used” or “ever exposed,” which do not capture the nuanced behaviors observed in this study. Even when large data sources, like NSDUH, capture cannabis frequency, most researchers collapse PCU into a single dichotomous measure, losing important trends. For example, among adults, there has been a 15-fold increase in the rate of daily and near-daily cannabis users. For the first time in history, this number has surpassed the number of daily and near-daily alcohol users.<sup>191</sup> Without frequency data, this significant trend would not have been identified.

In pregnant populations, oversimplification may lead to misclassification,<sup>122</sup> severely limiting insights into prevalence, trends, and the capacity to assess PCU’s effects on maternal and infant health outcomes. Furthermore, mismeasuring PCU could be interpreted as misrepresentation, violating ethical principles and guidelines outlined in the National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research’s Belmont Report.<sup>192</sup>

Public health officials, healthcare practitioners, and policymakers depend on research findings to make informed decisions and effectively communicate the risks of PCU to the public. Researchers must emphasize accuracy and take steps to avoid inaccurate or misleading results.<sup>193</sup> In the case of PCU and cannabis research, more broadly, researchers should avoid the use of binary PCU measures (ever used or ever exposed). Ideal PCU measures include (1) timing of use, (2) cannabinoid type, dose, and ratio, (3) frequency and quantity, (4) method of administration, and (5) specific products used. This is especially important given the sheer volume and availability of new - and often unregulated - cannabis and cannabis-derived products.<sup>81</sup> Risk profiles are urgently needed to understand the level of risk associated with various modes of

administration, doses, and products used. This is particularly important for identifying products and administration methods that lead to exposure to toxins known to cause fetal harm, like heavy metals<sup>194</sup> and carbon monoxide.<sup>29,195</sup>

The use of GEE in this study demonstrated a relatively straightforward approach to measuring PCU patterns, incorporating frequency and timing over the prenatal period. Other approaches have been recommended when using population-level data, such as trial emulation, difference-in-difference, interrupted time series, and regression discontinuity.<sup>136</sup> Some researchers have called for the development of standardized exposure assessments that include (1) universal and comprehensive cannabis questions and (2) THC exposure units that could be used across various administration methods, products, and doses.<sup>136</sup> Another way to inject rigor into cannabis measurements is to use core outcome sets, which consist of a minimum set of outcomes assembled through a consensus—building process.<sup>196</sup>

While these standardization efforts are underway, existing PCU monitoring sources must be updated. The Pregnancy Risk Assessment Monitoring System (PRAMS) core questionnaire (phase 9) and the “marijuana and prescription drugs” supplement, for example, should minimally measure cannabis frequency by trimester. PRAMS and NSDUH should also add questions to capture products used during pregnancy, especially given the availability of hemp-derived cannabinoid products and high-THC products. Finally, the administration methods must be collected to adequately understand (1) risk profiles and (2) to begin to understand the role of THC versus other toxicants, such as carbon monoxide and lead, in birthing people who use cannabis. Cannabis use patterns before and after pregnancy will allow for a better understanding of prevalence, trends, and changes over the perinatal period. Other questions

that better capture quit behaviors like attempts, outcomes, and timing, will also enhance understanding of PCU trends and behaviors on a population level. Such efforts align with the Centers for Disease Control and Prevention’s Cannabis Strategy Unit, which calls for expanding existing data sources to monitor use, product type, amount, mode, and frequency of use cannabis use.<sup>197</sup>

Efforts are also needed to better understand the patterns and prevalence of polysubstance use. The National Center on Birth Defects and Developmental Disabilities and Public Health Informatics Institute recently formed the Maternal and Infant Network to Understand Outcomes Associated with Opioid Use Disorder during Pregnancy (MAT-LINK).<sup>198</sup> In addition to information about OUD treatment outcomes, MAT-LINK also collects detailed data on alcohol, tobacco, cannabis, and other substance use, maternal health, and obstetric history and outcomes, drawing from administrative, electronic health records, pharmaceutical, and laboratory records. This integrated approach, while intended to monitor OUD treatment outcomes, could serve as a data source or model for cannabis and polysubstance monitoring and research efforts.<sup>198</sup>

### **Expanding Access to PCU Information**

Expanding access to information and improved measurement of PCU are inextricably linked. Continued reliance on inadequate measurement practices for PCU will undermine the clarity and reliability of the evidence base. This, in turn, perpetuates inconclusive and conflicting findings, leading to more confusion and a lack of trust among birthing people. The birthing people in this study described their frustration with the lack of access to information about PCU. This aligns with other qualitative studies in which birthing people describe available

PCU information as inconsistent, nonexistent, lacking scientific rigor, inconclusive, and conflicting.<sup>84,92,93,103</sup>

Some research indicates the most common place for pregnant people to gain information about PCU is in the digital environment, where the risk of misinformation and predatory marketing is high. Public health agencies continually fall short when providing access to evidence-informed and publicly available information. A content analysis of the websites of 51 state and five federal public health agencies revealed that only one federal agency and ten state agencies had published information on perinatal cannabis use. At the same time, most of these sites provided some details about the potential adverse health outcomes; only five offered resources to help individuals quit.<sup>156</sup> Similarly, in a content analysis of online media portrayal of PCU, only about half of the mentioned risks of PCU, while a third mentioned benefits.<sup>199</sup> Although it is difficult to track how online messages influence actual decision-making and PCU behaviors, non-narrative, science-based messaging has been associated with lower intentions to use cannabis during pregnancy.<sup>200</sup>

PCU information-seeking and informed decision-making are complex and contextual processes. For example, a “triangulation” process has been described in which birthing people integrate information, intuition, and immediate needs when making decisions about cannabis use.<sup>96</sup> Within these processes, a range of behaviors were identified, such as information seeking, information avoidance, cross-checking, sensemaking, and rating trustworthiness.<sup>96</sup> The findings of this study suggest additional layers and complexities that play into birthing peoples’ decision-making process around PCU. Access to information must also be considered within socio-structural contexts. Research suggests that public perception of cannabis use has shifted

from an “issue to fix” to a representation of personal agency and empowerment.<sup>201</sup> However, others argue that social acceptability and reduced “problematization” of cannabis are not extended to pregnant people, particularly those with marginalized and intersecting identities.<sup>201</sup>

### **Designing Equitable Clinical and Community Interventions**

Qualitative studies indicate that anywhere from one- to two-thirds of pregnant people did not disclose cannabis use with their prenatal care provider, citing fear of Child Protective Service (CPS) reporting and provider judgment.<sup>95,101</sup> Those who disclosed use describe interactions with their provider as inconsistent, punitive, and unhelpful.<sup>95,101</sup> A study by Holland et al. that observed prenatal care providers affirmed their experience. When pregnant patients disclosed cannabis use, 23% of providers made no acknowledgment, and 48% provided no specific counseling. Of the few who did provide counseling, 70% of their time was spent on legal implications and CPS investigations, and most gave vague, general statements and were unclear about the reasoning for their recommendations.<sup>75</sup>

The United States Preventive Services Task Force (USPSTF) recommends screening all adults, including pregnant people, for tobacco, alcohol, and other substance use and providing appropriate interventions and referrals to treatment and care when a need has been identified.<sup>202</sup> However, these recommendations do not offer guidance specific to cannabis or polysubstance use. While the Substance Abuse and Mental Health Services Administration (SAMHSA) recently published an evidence-based resource guide for clinicians on poly-substance use, they do not make recommendations specific to pregnant populations.<sup>203</sup> A handful of provider toolkits and guidance are available, however, ongoing efforts and funding are needed

to ensure these tools are utilized, accessible, and up to date. Additionally, research is required to establish whether these toolkits change providers' practices, policies, or approaches to PCU.

In addition to a lack of clinical guidance and training, there are other significant implementation barriers in both community and clinical settings. Tools specifically designed to screen for cannabis use during pregnancy are limited. Although some general prenatal substance use screening tools exist, the validation outcomes are often mixed or inconsistent. Moreover, the availability of validated tools may not guarantee their use. For example, despite the existence of several validated tools for alcohol use during pregnancy, one study found that only 20% of OB-GYN providers utilized a validated screening tool.<sup>204</sup> The lack of validated tools for screening polysubstance use during pregnancy is even more pronounced.<sup>205</sup> High-quality, birthing person-centered screening tools are needed to understand better fetal exposure to cannabis along with important contextual information such as (1) reasons for use, (2) perceived benefits, (3) cannabis-related goals, (4) social influences, and (5) impact of use on daily life. Expanded and contextualized screening efforts may help identify birthing people with a greater need for intervention and support based on heavier use, continued use, co-morbid mental and behavioral health conditions, and those who are using unregulated products, such as cannabinoid hemp products.

Findings from this dissertation demonstrate a wide range of beliefs, reasons for use, quit intentions, and influences on PCU. Understanding these patterns and predictors of PCU will help guide effective clinical and community interventions. According to the Substance Abuse and Mental Health Services Administration, there is currently no evidence on individual programs for the prevention of perinatal cannabis use."<sup>120</sup> A systematic review examined nine studies on PCU

interventions and found massive variations in approaches, doses, and intervention lengths.<sup>143</sup>

While some of these interventions showed initial promise, it was nearly impossible to draw any conclusions due to measurement issues, participant pooling, non-standardized PCU measurement, and heterogeneous populations.

Evidence-based tools such as Screening, Brief Intervention, and Referral to Treatment hold some initial promise to address PCU. For example, a quality improvement project in three Texas hospitals found that establishing regular PCU screening was the key to SBIRT success. Once a screening occurs, brief intervention and referral to treatment adherence rates were extremely high, between 95% and 100%.<sup>157</sup> Two additional studies reviewed the feasibility and acceptability of electronic screening and brief intervention. Although both had small samples and the impact on actual behavior change was not measured, participants gave high ratings for satisfaction and acceptability.<sup>206,207</sup>

Another significant barrier in community and clinical interventions is that birthing people of color have been systematically discriminated against. For example, a large study using hospital discharge data found that Black birthing people were tested at twice the rate of non-Hispanic whites.<sup>51</sup> A retrospective cohort study also found that while Black pregnant people were more likely to self-report use than Whites, they were not more likely to have screened positive.<sup>58</sup> In the observational study by Holland, described above, Non-Hispanic Black birthing people were almost ten times as likely to receive punitive counseling than non-Hispanic whites.<sup>75</sup>

A policy statement from ACOG outlines its opposition against punitive measures, mandated drug testing, lack of uniform policies around screening, testing, and reporting, testing of newborns without consent, reporting patients to law enforcement, and subjecting

patients to interrogation.<sup>137</sup> However, few concrete, proactive action steps are offered other than advocating for harm reduction, a primary prevention approach, and educating providers about the unconstitutionality of unconsented procedures.<sup>137</sup> Institution-level and provider-level accountability practices and policies that identify and rectify racial inequities are urgently needed.

### **Cross-sector Collaboration**

Equitably addressing prenatal substance use requires collaboration across multiple systems. One of the strategic pillars of the Centers for Disease Control and Prevention's Cannabis Strategy Unit involves building partnerships with healthcare providers and systems, public safety sectors, schools, and community coalitions.<sup>197</sup> The strategic plan does not include partnerships with cannabis retailers, a major oversight given the cannabis market in the US is expected to exceed \$40 billion in 2024.<sup>77</sup> Data from NSDUH showed the majority (92%) of pregnant people found it easy or relatively easy to acquire cannabis,<sup>5</sup> and that perceptions about accessibility are associated with higher rates of use.<sup>5,48</sup> Moreover, a study from Northern California found that greater retail availability was associated with higher odds of PCU, and a dose-response effect was noted.<sup>14</sup> Additionally, a longer drive time to retailers was associated with lower odds of PCU, and higher retail density was associated with greater odds of PCU.<sup>14</sup> Concerningly, one study of 400 dispensaries in Colorado found that nearly 70% of budtenders recommended cannabis for morning sickness.<sup>208</sup> In a different qualitative study, birthing people reported looking to cannabis retailers for information about PCU, describing a sense of loyalty and community, and described budtenders as experts, caring, and non-judgmental.<sup>94</sup>

CDC's strategic plan also does not mention partnerships with the child welfare sector, which plays a pivotal role in addressing the impacts of substance on maternal and child health populations. In 2022, nearly 50,000 infants were referred to CPS agencies as infants of prenatal substance exposure (IPSE).<sup>209</sup> Black infants were more than four times more likely to be reported to Child Protective Services (CPS) than Whites despite similar rates of use.<sup>76</sup> Data from the National Child Abuse and Neglect Data System has also documented racism and systemic bias in multiple outcomes, including reporting, substantiation, and out-of-home placement.<sup>210-</sup><sup>212</sup> To receive Child Abuse Prevention and Treatment Act (CAPTA) funds, states are required to have policies and procedures in place to address the needs of substance-exposed infants through a plan of safe care (POSC). A POSC is designed to promote the safety and well-being of the infant by addressing the health and substance use treatment needs of the infant and family members. Cross-sector collaboration is urgently needed as the implementation of these policies, along with the rate of infant removal from the home due to substance use disorders, vary significantly by state. The National Center on Substance Abuse and Child Welfare recently launched a training series to assist cross-system collaborative teams in reducing substance use stigma in interactions, expectations, and policies impacting families. It outlines several strategies, including the intentional use of language to combat stigma and promote engagement with parents and family members affected by substance use.<sup>213</sup> The Anne E. Casey Foundation also offers examples of best practices from states, including cross-system collaboration, increased knowledge of state policies, and efforts to understand and address implicit bias and disparities.<sup>214</sup>

## **Informing Policy Changes**

Participants in this study expressed fear and frustration with the current policy landscape in Wisconsin. Wisconsin has among the most punitive prenatal substance use policies in the nation. The Unborn Child Protection Act (Act 292), passed in 1997, asserts that pregnant people who use substances can be accused of “unborn child abuse.” It allows the state to take physical custody of a pregnant person and appoint a lawyer to a fetus or even a fertilized egg. The proceedings take place in juvenile court, and pregnant people are not entitled to legal representation.<sup>138</sup> Wisconsin is one of a handful of states that allow civil detention for pregnant people accused of substance use. Punitive prenatal substance use policies are clearly linked with worse perinatal outcomes.<sup>137</sup> Thus, to improve maternal and child health outcomes, states should (1) remove substance use as grounds for child abuse and/or civil commitment, (2) remove reporting requirements for substance use, (3) add priority access for pregnant people in treatment programs, and (4) prohibit discrimination against pregnant people who use substances in their state statutes.

Another policy issue warranting immediate action is the lack of regulation of hemp-derived cannabinoid products. Some states have taken action to close the Farm Bill loophole. however, federal action is needed to set requirements regarding testing, packaging, labeling, and limits on potency and concentration.<sup>215</sup> While not specific to birthing people, restrictions on youth access to these products should also be prioritized. This issue is of the utmost importance in Wisconsin and other states where medical and adult use is restricted, where the use of these products is more prevalent compared with states where medical and adult use is legal.<sup>216</sup>

### **Prioritizing Participatory Approaches**

Finally, future PCU research and public health efforts should be guided by community-based participatory research (CBPR) principles, a research orientation in which communities are active participants, co-learners, and decision-makers throughout the research process.<sup>201</sup> Other engagement practices, such as community advisory boards, author positionality statements, mixed methods research, and qualitative studies with diverse populations, can and should be prioritized in this work. Centering the experiences of birthing people in this work will ensure that findings are not divorced from important contextual influences such as economic conditions, industry, and political influences on PCU.<sup>110,111</sup> This work should employ theoretical frameworks. Life course theory proved well-suited for this study and has been recommended by others.<sup>110</sup> Other frameworks recommended to address cannabis use include the social-ecological model<sup>217</sup> and intersectional feminist theory.<sup>201</sup>

Research on cannabis and all prenatal substance use carries significant responsibility, as misinterpretations, poor study design, and lack of transparency can lead to severe consequences. For instance, a series of discredited studies on the effects of cocaine exposure in infants resulted in punitive policies, harmful practices, and enduring stigma.<sup>72</sup> Even studies that are less overtly flawed can unintentionally marginalize pregnant individuals who use substances. In addition to CBPR approaches, Future research should shift away from the “problematization” of PCU and move towards identifying solutions and strategies that empower pregnant people to make informed decisions and choices about cannabis use during pregnancy.

## Strengths and Limitations

The study's main strength was mixed methods, particularly convergent parallel design, which treats quantitative and qualitative data equally. This approach ensured participants' experiences held weight and value throughout the study, especially during the interpretation and integration phase. Another key strength of this study was its high ecological validity. All data were collected within a well-established and trusted community-based program as part of an established therapeutic relationship. A third strength was the use of GEE, which allowed for the examination of multiple influences on PCU patterns over the prenatal period, accounting for within-subject correlation and the influence of time. Additionally, reflexive thematic analysis and synthesized member check (SMC) promoted a systematic interpretation of qualitative findings. Finally, the integration of an individual-level behavior model with a multi-level theory provided a deeper understanding of the most salient upstream and downstream influences on cannabis use among birthing people.

The quantitative measures used are self-reported; thus, they may be subject to recall or social desirability bias. Recall bias was minimized by using 30-day timeline follow-back (TLFB) intervals to measure prenatal substance use. Longer TLFB intervals, such as 90-day and year-long lookbacks, may have reduced accuracy for estimating substance use.<sup>218</sup> Social desirability bias is a significant limitation in previous PCU literature. This study minimized this bias through rapport building, careful survey design, and word choice.<sup>140,219</sup> Surveys used by the First Breath program have been updated multiple times over its 20+ year history through a continuous quality improvement process. These efforts aimed to improve clarity and comprehension, solicit truthful responses, and decrease stigma. For example, when asking about the frequency

of substance use, response options are presented with the highest frequency first (daily, weekly, monthly, once or twice, none) to normalize behaviors. Additionally, some of the cannabis use-related questions went through a cognitive testing process before this study, including one new measure (reasons for use) that was suggested by and subsequently co-written by participants.

This dissertation was not without limitations, most notably, a small sample size, which was a key limitation in quantitative analyses. Issues of reduced statistical power, less precise estimates, and wider confidence intervals reduced the certainty of the findings and increased the susceptibility of Type I and II errors. The sample size was less of an issue with qualitative analyses, where the focus was on meaningful exploration of marginalized groups' experiences, addressing structural inequalities, and interpreting findings in a way that is responsive to the group's unique needs.<sup>148,220</sup>

Attrition is another weakness of this study and a threat to internal validity. Based on previous research and evaluation conducted by First Breath, follow-up survey completion rates are around 50-60%, even with intense efforts by the program staff to complete visits. These low attrition rates resulted in missing data. A weighted GEE model, in which a missingness model is specified, would have been the ideal approach to missing data. However, the procedures could not run due to missingness patterns in the dataset. Additionally, two multiple imputation approaches (multivariate normal distribution and fully conditional specification) were attempted, but, like Weighted GEE, were unable to properly pool estimates due to the structure of the data.

Measurement limitations were also noted. For example, how "intent" and "attempt" were measured in this study may have fully restricted the ability to understand their role in PCU behavior change. Future studies should explore (1) measuring intention longitudinally, as intentions may change over the course of the prenatal period, and (2) measures that better measure the complexities of quit attempts, such as tracking the number of serious quit attempts or assessing the level of effort involved. Additionally, it is worth noting that intent and quit attempts may not hold as much relevance when examining substance use behaviors in marginalized populations with complex needs. This study used repeated measures of depression and anxiety severity. While an improvement over binary measures of perinatal mental health (e.g., a birthing person has or does not have depression), it did not capture other mental and behavioral health conditions, nor the perceived burden of these conditions.

One further measurement consideration is the use of GAD-7 and PHQ-9. While both have been validated for use in perinatal populations, they may not have captured the unique mental health challenges associated with pregnancy. For example, future studies that focus on the relationship between PCU and perinatal depression should consider using the Edinburgh Postnatal Depression Scale (EPDS) over the PHQ-9.<sup>221</sup> Similarly, in this study, social support and stress levels were measured as "high, medium, and low." Validated tools should be used in future studies examining the role of social support and stress on PCU.

In the interaction terms, both the predictor and trimester variables were treated as continuous. Trimester was treated as a continuous variable for many reasons, including alignment with research questions and hypotheses, more efficient interpretation of interaction terms, and model fit. However, treating both predictor and trimester variables in the

interaction terms as categorical would allow for the examination of trimester-specific effects and a more detailed examination of the interaction of trimester and the predictor at each “level.” This study had a small sample size, so adding more parameters would have further reduced the statistical power. This approach would be better suited for studies with larger sample sizes.

### **Ethical Challenges and Protections**

This study has several ethical considerations. The criminalization of cannabis disproportionately impacts people of color, low-income people, and birthing people.<sup>67</sup> Significant protections were implemented to buffer against these ethical concerns and protect participants. To safeguard participants’ confidentiality, this study used only de-identified data previously collected within the safety of a well-established program that (1) has demonstrated success handling and securing sensitive data and (2) is committed to participant confidentiality and nonpunitive approaches. Additionally, all data were collected as part of a counseling-based interaction between HEs and participants, who had been working together, building trust and safety, for more than a year. All individuals involved in data collection (HEs) and analysis (KA) engaged in individual and group reflexivity practices to prevent reinforcing stereotypes and biases. Synthesized Member Checking (SMC) was a critical component of this study aimed at reducing stigma and bias by working with participants to validate, verify, and assess qualitative findings.

### **Conclusion**

Given the rapidly changing legal environment, a growing cannabis industry, increasing rates of PCU, and potential impacts on maternal and child health, efforts to address PCU are

urgently needed. Public health, healthcare, policy, and industry sectors need to work together to develop approaches to improve non-punitive, evidence-informed, and equity-focused policies and practices. Most importantly, birthing people with lived experience who have been historically excluded from this work must be involved in these efforts. This study's results can guide more effective, non-punitive prevention, intervention, and policy efforts to protect and promote the health of pregnant people, infants, and children.

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## Appendices

### Appendix A. List of Quantitative and Qualitative Measures

Measure	Question/Description	Response Options	Quant or Qual	Timepoint <sup>a</sup>
<b>General Measures</b>				
Participant Identifier	Five-digit number used to link surveys	Five-digit ID	QT	BL, PN4, PN7, PP1
Intervention dose	Number of prenatal counseling minutes	Number of minutes	QT	Composite
<b>PCU measures</b>				
Past 30-day cannabis use	Timeline follow-back: During the past 30 days, how many days did you use cannabis?	Number of days (0-30)	QT	BL, PN4, PN7
Cannabis quit attempts	Did you attempt to quit cannabis during pregnancy?	No, Yes	QT	PP1
Changes over prenatal period	Which best describes the participant's change in cannabis use over the prenatal period?	Quit, Cut down, Continued use	QT	PP1
<b>Domain 1: Demographic measures</b>				
Age	How old are you?	Age in years	QT	BL
Race/Ethnicity	How do you typically describe your race or ethnicity?	Black or African American, White, Other	QT	BL
Income	What is your current household income?	Less than \$10,000, \$10,000 - \$19,999, \$20,000 - \$29,999, \$30,000 or more	QT	BL
Education	How many years of school did you complete?	Less than high school, High school/GED, More than high school	QT	BL
Employment status	Which best describes your employment status?	Not currently employed, Employed part-time, Employed full-time	QT	BL

Relationship status	Which best describes your relationship status?	Single, Married/Committed, Divorced	QT	BL
<b>Domain 2: Cognitive measures</b>				
Reasons for cannabis use	What are the reasons you use cannabis?	Select all that apply: Make things more fun/enjoyable, Relief from stress, Manage symptoms of depression or anxiety, Escape from current/past problems, Handle certain people, Feel calm, relaxed, or level, Social reasons, Boredom, Habit/Addiction	QT	BL
Quit challenges and successes	Did you attempt to make changes to your cannabis use during pregnancy? If so, what were some of the challenges and successes you experienced?	Open-ended	QL	Interview
Reasons for tobacco use	What are the reasons you use tobacco?	Select all that apply: Make things more fun/enjoyable, Relief from stress, Manage symptoms of depression or anxiety, Escape from current/past problems, Handle certain people, Feel calm, relaxed, or level, Social reasons, Boredom, Habit/Addiction	QT	BL
Cannabis quit intentions	What are your tobacco-related goals?	Quit, Cut down, Continue use	QT	BL
Tobacco quit intentions	What are your tobacco-related goals?	Quit, Cut down, Continue use	QT	BL
<b>Domain 3: Psychological measures</b>				

Stress level	What is your current stress level?	High, Medium, Low	QT	BL
Impact of cannabis on stress	What is the relationship between stress and cannabis in your life?	Open-ended	QL	Interview
Mental health disorder	Do you/have you ever suffered from a mental illness or behavioral health disorder?	No, Yes	QT	BL
Impact of cannabis on mental health	In what ways does cannabis impact your mental health, positively or negatively?	Open-ended	QL	Interview
Mental health and cannabis timing	Please select the statement that best describes you.	Symptoms of my mental health condition started a) BEFORE I started using cannabis, b) AFTER I started using cannabis, c) AT THE SAME TIME as when I started using cannabis, d) I don't remember, e) I don't have a mental health condition.	QT	SMC <sup>4</sup>
Depression Score	What was participant's PHQ-9 <sup>b</sup> score?	Score 0-27	QT	PN4, PN7, PP1
Depression Severity	What was the interpretation of the participant's PHQ-9 <sup>b</sup> score	Minimal (0-4), Mild (5-9), Moderate to Severe (10-27)	QT	PN4, PN7, PP1
Anxiety Score	What was participant's GAD-7 <sup>c</sup> score?	Score 0-27	QT	PN4, PN7, PP1
Anxiety Severity	What was the interpretation of the participant's GAD-7 <sup>c</sup> score	Minimal (0-4), Mild (5-9), Moderate to Severe (10-21)	QT	PN4, PN7, PP1
<b>Domain 4: Social-relational measures</b>				
Cannabis users in social circle	How many people in your close social circle (friends, family) use cannabis?	None/Few, Some, Most/All	QT	BL

Influence of relationships on cannabis	Tell me about the important relationships in your life (partner, friends, family, children). In what ways – positive or negative - do these relationships influence your cannabis use?	Open-ended	QL	Interview
Social norms about cannabis	In your community, what are people’s general feelings toward cannabis?	Open-ended	QL	Interview
Concern about cannabis use	Has a friend, family, or healthcare professional ever expressed concern about your cannabis use or suggested to stop/cut down?	No, Yes	QT	BL
Household cannabis rules	Which is the best description of smoking in your home <u>currently</u> ?	Never allowed, Allowed	QT	BL
Social support level	How much support (day-to-day help, emotional support) do you get from the people in your life?	High, Medium, Low	QT	BL
<b>Domain 5: Substance use measures</b>				
Early exposure	When you were a child, did any of your caregivers use cannabis? If so, how do you think that impacted your own use?	Open-ended	QL	Interview
Cannabis initiation experiences	How old were you when you first tried cannabis? What do you remember about that time?	Open-ended	QL	Interview
Cannabis initiation age	How old were you when you first tried cannabis?	Age at initiation	QT	BL
Preconception cannabis use	In the year before you were pregnant, how often did you use cannabis?	Daily, Weekly, Less than weekly	QT	BL

Substance use disorder	Do you currently or have you ever had a substance use disorder or been treated for an addiction to drugs or alcohol?	No, Yes	QT	BL
Current tobacco use	On average, how many cigarettes per day (CPD) did you smoke in the past seven days?	None, Less than five, Six or more	QT	BL, PN4, PN7, PP1
Co-use reasons	Can you explain more about why you co-use cannabis and tobacco?	Open-ended	QL	SMC <sup>d</sup>
Co-use practices	Can you explain more about how you co-use cannabis and tobacco?	Open-ended	QL	SMC <sup>d</sup>
<b>Domain 6: Structural measures</b>				
Cannabis-related stigma or discrimination	Tell me about any stigma or discrimination you've experienced because of your cannabis use.	Open-ended	QL	Interview
Retail influences	In what ways does cannabis marketing (like ads, displays in stores, social media, or smoke shops) influence your cannabis use?	Open-ended	QL	Interview
Policy influences	In what ways have cannabis-related laws or policies impacted you?	Open-ended	QL	Interview

<sup>a</sup> BL, Baseline (first trimester); PN4, Prenatal month 4 (second trimester); PN7, Prenatal month 7 (third trimester); PP1, Postpartum month 1, Interview, occurred during pregnancy or within one year of delivery

<sup>b</sup> Patient Health Questionnaire (PHQ-9)

<sup>c</sup> Generalized Anxiety Disorder Screening (GAD-7)

<sup>d</sup> Synthesized Member Check survey

## Appendix B. Conceptual Model Components

<b>Domain 1: Demographic</b>		
<b>Measurement</b>	<b>Corresponding Constructs &amp; Definitions</b>	
	Lifecourse Theory	Integrated Behavior Model
Race/Ethnicity (QT)	<b>Timing</b> Affects when pregnancy occurs.	<b>Other Factors</b> Describes the other factors that influence behavior such as demographics and environment
Age (QT)		
Household income (QT)		
Education (QT)	<b>Cumulative advantage/disadvantage</b> Describes socio-economic advantages (or disadvantages) that accumulate over the lifespan.	
Employment Status (QT)		
<b>Domain 2: Cognitive</b>		
<b>Measurement</b>	<b>Corresponding Constructs &amp; Definitions</b>	
	Lifecourse Theory	Integrated Behavior Model
Reasons for use (QT/QL)	<b>Human Agency</b> Describes the choices, decisions, and actions individuals engage in (also called behaviors), influenced by motivation, goals, beliefs, and individual characteristics. Decisions are made within the confines of the individual's social circumstances.	<b>Personal Agency</b> Describes the individual's perceived control over the behavior change. This includes their 1) perceived difficulty to change and 2) self-efficacy, the individual's confidence in their ability to perform the behavior.
Intent to quit (QT/QL)		
Quit challenges and successes (QL)		
Agency (QL)		
		<b>Behavioral Intention</b> Refers to the individual's intent to change their behavior.
		<b>Salience</b> Describes the level of importance of the behavior.
		<b>Attitude Toward Behavior</b> Refers to overall favorableness toward behavior, including 1) experiential attitude which refers to the emotional response to the idea of the behavior, and 2) instrumental attitude which is determined by beliefs about the outcomes of the behavior.

<b>Domain 3: Psychological</b>		
<b>Measurement</b>	<b>Corresponding Constructs &amp; Definitions</b>	
	Lifecourse Theory	Integrated Behavior Model
Mental health condition (QT/QL) Anxiety and depression (QT) Stress level (QT/QL)	<b>Cumulative advantage/disadvantage</b> Describes the ways in which conditions and experiences accumulate over the lifespan, contributing to mental health, stress, and access to care	<b>Other Factors</b> Describes the other factors that influence behavior such as demographics and environment
<b>Domain 4: Social-relational</b>		
<b>Measurement</b>	<b>Corresponding Constructs &amp; Definitions</b>	
	Lifecourse Theory	Integrated Behavior Model
Relationship status (QT) Influence of partner (QL) Cannabis users in social circle (QT) Others' concern about cannabis use (QT) Influence of friends and family (QL) Social norms (QL) Social support (QT)	<b>Linked Lives</b> Refers to the ways in which individuals are inextricably linked to others through relationships and society at large.	<b>Perceived Norm – Injunctive</b> Describes the social pressure to perform or not perform the behavior. Injunctive refers to what people think about the individual's use.  <b>Perceived Norm –Descriptive</b> Social pressure to perform or not perform. Descriptive perceived norms refer to the perceptions about what other people are doing.
<b>Domain 5: Substance Use</b>		
<b>Measures</b>	<b>Corresponding Constructs &amp; Definitions</b>	
	Lifecourse Theory	Integrated Behavior Model
Early Exposure (QL) Initiation (QT/QL) Preconception use (QT) Tobacco co-use (QT/QL) Substance use disorder (QT)	<b>Early programming</b> Refers to prenatal, intergeneration, and childhood events that make someone more vulnerable to substance use later in life.  <b>Timing</b> Refers to people's behavioral patterns, duration of substance use, and the order of events (sequencing).  <b>Trajectories</b> Describes the long-term patterns of the individual's behavior. Substance use trajectory co-occurs with life experiences.	<b>Habit</b> Describes the process of the behavior becoming habitual after performing it repeatedly

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**Transition**

Describe a brief timeframe embedded within trajectories (pregnancy)

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**Domain 6: Structural**

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**Measurement****Corresponding Constructs & Definitions**

	Lifecourse Theory	Integrated Behavior Model
Retail environment (QL)	Time and Place: Describes the way in which individuals are situated in historical, social, and cultural contexts.	Environmental Constraints: Factors that enable or constrain a person's behavioral performance.
Policy environment (QL)		
Stigma/bias (QL)		

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<sup>a</sup>QT, Quantitative measures; QL, Qualitative measures; QT/QL, Quantitative and qualitative measures

## Appendix C: Semi-structured Interview Guide

### COMPLETE BEFORE THE INTERVIEW (Note: Health Educator in *italics*)

1. Health Educator Name
2. Participant ID
3. Has the participant been enrolled in First Breath since January 2022?
  - Yes
  - No – *Not eligible*
4. Which of the following best describes participants' prenatal use at baseline? Check only one.
  - Tobacco Only
  - Cannabis Only
  - Tobacco and Cannabis
  - Other Combination
5. Did the participant experience a miscarriage, stillbirth, or infant death during this most recent pregnancy?
  - Yes – *Adjust language during the interview – using “pregnancy” instead of “baby”*
  - No

### COMPLETE DURING INTERVIEW

#### Introduction

Thank you for agreeing to participate in the 2023 First Breath Participant Advisory Group. Our goal is to learn more about tobacco, alcohol, and cannabis use and cessation during pregnancy. This will help make sure pregnant people have access to accurate information and high-quality, nonjudgmental care they need and deserve. Thank you for sharing your story.

#### About the Interview

- The interview will take around 60 minutes total to complete.
- If you don't understand the question, please let me know. I will ask it differently. I may ask follow-up questions to better understand your story.
- You can skip any questions that you don't feel comfortable answering. Just say “skip” or tell me you don't want to answer.
- You can stop the interview at any time. Just say “stop” or tell me you want to stop the interview.
- Your responses to the interview are confidential. That means your responses will **NOT** be linked to your personal information.
- With your permission, I will record the transcripts (written record of our interview).
- Your responses will be combined with around 20 other participants from around the state.

- The combined responses will be reviewed by First Breath staff. We will identify the major themes and come up with recommendations for improving care for pregnant people who use tobacco, alcohol, and cannabis.
- You will have a chance to review and provide feedback on the themes and recommendations before we share it with anyone.
- A report of the themes and recommendations will be shared with you, other participants, and program funders and partners.
- Do you have any questions at this point?

**Consent to record and transcribe**

- Next, I will ask for your verbal consent to record our interview. Just a reminder this is confidential.
- I am going to read a statement and you will tell me if you agree. “I give my permission for this interview to be recorded and transcribed. I understand that the recording will only be used to check the transcript and will be permanently deleted after 120 days. I understand that my name or other identifying information will NOT be linked to the final version of the transcript.”

1. Do you agree with that statement?
2. Verbal consent obtained on (DATE) by (HEALTH EDUCATOR NAME)
3. Are you ready to begin?

**START RECORDING & MAKE SURE TRANSCRIPTS ARE WORKING**

*IMPORTANT*

- Remember, you DO NOT need to write down/hand transcribe their responses.
- Take notes (in a notebook or Word doc) and jot down your observations and reflections, then transfer these to the Alchemer Survey after the interview.

**Cannabis Interview Questions**

1. When you were a child, did any of your caregivers use cannabis? If so, how do you think that impacted your own use?
2. How old were you when you first tried cannabis? What do you remember about that time?
3. What was going on in your life when you found out you were pregnant with [baby name]/during the last pregnancy?
4. Did you attempt to make changes to your cannabis use during pregnancy? If so, what were some of the challenges and successes you experienced?
5. *If no attempts to change were made, skip this question.* Did changing your cannabis use during pregnancy lead to other changes in your life? Tell me about it.
6. Tell me about the important relationships in your life (partner, friends, family, children). In what ways – positive or negative - do these relationships influence your cannabis use?
7. In your community what are people’s general feelings towards cannabis? *Prompt: For example, is cannabis use generally accepted/normal in your community?*

8. In what ways does cannabis impact your mental health, positively or negatively? *Prompt: For example, do you use cannabis to manage mental health symptoms? Does cannabis ever make your mental health worse?*
9. What is the relationship between stress and cannabis in your life? *Prompt: For example, do you use cannabis to manage stress/alleviate your stress? Does cannabis ever make your stress worse?*
10. Tell me about any stigma or discrimination you've experienced because of cannabis. *Prompt: For example, has a health or social service provider ever treated you differently because of your cannabis use? Have you ever experienced CPS or law enforcement involvement due to your cannabis use?*
11. In what ways does cannabis marketing (like ads, displays in stores, social media, or smoke shops) influence your cannabis use?
12. In what ways have cannabis-related laws or policies impacted you?
13. Of all the things we discussed (early exposure, relationships, community, mental health, stress, marketing, policies) what has the *biggest* impact on your cannabis use/cessation?
14. Is there anything we *didn't* discuss that impacts your cannabis use/cessation?
15. Is there anything else you'd like to share about cannabis use and cessation during pregnancy?

### **Tobacco Interview Questions**

1. When you were a child, did any of your caregivers use tobacco? If so, how do you think that impacted your own use?
2. How old were you when you first tried tobacco? What do you remember about that time?
3. What was going on in your life when you found out you were pregnant with [baby name]/during the last pregnancy?
4. Did you attempt to make changes to your tobacco use during pregnancy? If so, what were some of the challenges and successes you experienced?
5. *If no attempts to change were made, skip this question.* Did changing your tobacco use during pregnancy lead to other changes in your life? Tell me about it.
6. Tell me about the important relationships in your life (partner, friends, family, children). In what ways – positive or negative - do these relationships influence your tobacco use?
7. In your community what are people's general feelings towards tobacco? *Prompt: For example, is tobacco use generally accepted/normal in your community?*
8. In what ways does tobacco impact your mental health, positively or negatively? *Prompt: For example, do you use tobacco to manage mental health symptoms? Does tobacco ever make your mental health worse?*
9. What is the relationship between stress and tobacco in your life? *Prompt: For example, do you use tobacco to manage stress/alleviate your stress? Does tobacco ever make your stress worse?*
10. Tell me about any stigma or discrimination you've experienced because of tobacco. *Prompt: For example, has a health or social service provider ever treated you differently because of*

*your tobacco use? Have you ever experienced CPS or law enforcement involvement due to your tobacco use?*

11. In what ways does tobacco marketing (like ads, displays in stores, social media, or smoke shops) influence your tobacco use?
12. In what ways have tobacco-related laws or policies impacted you?
13. Of all the things we discussed (early exposure, relationships, community, mental health, stress, marketing, policies) what has the *biggest* impact on your tobacco use/cessation?
14. Is there anything we *didn't* discuss that impacts your tobacco use/cessation?
15. Is there anything else you'd like to share about tobacco use and cessation during pregnancy?

### **CLOSING**

That is the end of the interview! Unless you have any last thoughts, I am going to turn off the recording now.

### **END RECORDING**

Thank you very much for your time and energy during this interview. Your story will help make sure pregnant people have access to the accurate information and high-quality, nonjudgmental care they need and deserve.

Before we wrap up, I have a few quick questions. First, we would like to send you a \$50 gift card for your participation today. Verify address on file.

As mentioned at the start of the interview, we will be creating a report to help improve care for pregnant people who use cannabis. Before sharing the report with anyone, we would like a few participants to review the report and provide feedback. This is called "member check" and will take place this fall. To participate, I will send you a link to an online survey. You will receive a \$25 gift card for your time.

1. Would you like to participate in the member check?
  - Yes - May we text you the link to the online survey? *Verify phone number on file.*
  - No

## Appendix D. Synthesized Member Check Survey (Paper Version)

### Welcome

Thank you for participating in First Breath’s annual participant advisory group this summer. During your interview, you said you were interested in “member checking” the results. This is a way to ensure our summary report reflects your experience and that we didn’t miss anything.

If you would still like to participate, please complete the survey by Friday, Dec 8, 2023. You will receive a \$50 gift card as a thank you.

### About this Survey

- This is an online survey that will take around 30 minutes.
- The survey requires some reading (300-800 words, depending on which sections you are asked to complete). If this isn't a good option for you, let your Health Educator know and you can do the survey by phone.
- It is CONFIDENTIAL. Your name will NOT be connected to your responses.
- Click “Next” to get started!

### Prenatal Cannabis Use Themes

1. How well does each theme match your experience?
  - A lot
  - A little
  - Not at all
2. What would you change?
3. What would you add?
4. We want to better understand the direction of the relationship between cannabis and mental health conditions (like depression, anxiety, and ADHD). Please select the statement that best describes you.
  - Symptoms of my mental health condition started BEFORE I started using cannabis.
  - Symptoms of my mental health condition started AFTER I started using cannabis.
  - Symptoms of my mental health condition started AT THE SAME TIME as when I started using cannabis.
  - I don't remember.
  - I don't have a mental health condition.
5. What else would you like to share about prenatal cannabis use?

### Prenatal Tobacco Use Themes

1. How well does each theme match your experience?

- A lot
- A little
- Not at all

2. What would you change?

3. What would you add?

### Tobacco & Cannabis Co-Use Themes

1. How well does each theme match your experience?

- A lot
- A little
- Not at all

2. What would you change?

3. What would you add?

4. Can you explain more about WHY you co-use cannabis and tobacco (current or past)? *For example, do you use one to boost the effect of the other? Does your use of one reduce the negative impacts of the other? Does it depend on who you are with/the situation?*

5. Can you explain more about HOW you co-use cannabis and tobacco (current or past)? *For example, do you mix them together (in a blunt, joint, or vape)? Use one right after the other? Does it depend on who you are with?)*

## Appendix E. Thematic Map

<b>Theme 1: “I tried to stop.” Pregnancy as a turning point in cannabis use</b>	
Code	Definition
PCU evaluation	Participants’ descriptions of the extent to which they intentionally evaluated their use of cannabis during pregnancy
Interplay between cannabis and pregnancy-related conditions	Participants’ descriptions of the dynamic and changing role of pregnancy-related conditions (nausea, vomiting, low appetite, sleep issues) on their decision to use to discontinue PCU
Benefits of PCU decision	Participants’ descriptions the benefits associated with continuing or discontinuing cannabis during pregnancy
Preconception use and circumstances	Participants’ descriptions of their life circumstances before or during pregnancy and how those influenced PCU
Quit intentions/plans	Participants’ descriptions of their quit intentions or plans for changes to their cannabis use during pregnancy
Changes to cannabis use	Participants’ descriptions of their actual changes to cannabis use during pregnancy
Challenges/facilitators to PCU changes	Participants’ descriptions of the challenges or facilitators they experienced when trying to make changes to their cannabis use
Influence of tobacco co-use	Participants’ descriptions of the influence of co-tobacco use on their prenatal cannabis use
Other substance use/substance use disorder	Participants’ descriptions of the influence of other substance use and/or substance use disorder on their cannabis use during pregnancy
Influence of work/employment	Participants’ descriptions of the influence of their current, past, or future employment on their cannabis use
Health effects on baby	Participants’ perceptions of the effects of their cannabis use on their baby; included both harms/risk and benefits
<b>Theme 2: “It helps me not feel everything at once” Cannabis as an emotional regulator</b>	
Code	Definition
Coping mechanism to deal with stressful life events	Participants’ descriptions of using cannabis to manage stressful life events, for example trauma, violence, housing insecurity, relationship changes, mistimed/unintended pregnancy
Emotional regulation strategies before pregnancy	Participants’ descriptions of using cannabis to regulate emotions before pregnancy, for example using cannabis as an “escape” or to “not be there”
Emotional regulation strategy during pregnancy	Participants’ descriptions of using cannabis to regulate emotions during pregnancy, for example using to manage future emotions/situations, or to regulate emotions in the moment

Conflicting feelings	Participants' descriptions of conflicting feelings they felt about using cannabis to regulate emotions, for example describing cannabis as a temporary fix or false need
<b>Theme 3: "You have to dig deeper." The complicated link between mental health and cannabis</b>	
Code	Definition
Mental health and cannabis before pregnancy	Participants' descriptions of the relationship between mental health and cannabis before pregnancy, for example using cannabis to manage depression, childhood trauma, or suicidal ideation
Mental health and cannabis during pregnancy	Participants' descriptions of the relationship between mental health and cannabis during pregnancy, for example using cannabis to manage depression, anxiety, suicidal ideation, ADHD, PTSD, and serious mental conditions
Cannabis as a cure	Participants' descriptions of cannabis as a "cure" or close to a cure
Comparison of cannabis to other mental health treatment/medications	Participants' comparison of cannabis to other mental health treatment or medications, for example fewer side effects, safer, or more natural
Complicated/nuanced relationship	Participants' descriptions of the complicated relationship between mental health and cannabis, for example their use of cannabis masking or not fixing deeper issues
Dependency	Participants' descriptions of cannabis dependency or feeling unsure about the line between coping and dependency
<b>Theme 4: "It changed our dynamics." For better or worse, relationships influence PCU</b>	
Code	Definition
Early exposure	Participants' descriptions of early exposure to cannabis (prior to initiation); often parents, siblings, or other family members
Initiation and early use	Participants' descriptions of the social influences on their cannabis initiation and early use; often siblings and peers Before pregnancy, peers, parents, and siblings influenced use
Family and friend influences on PCU	Participants' descriptions of the social influences of friends and family on their cannabis use during pregnancy; this included bidirectional influences (leading to more/continued or less/discontinuation of cannabis use)
Partner influence on behavior change	Participants' descriptions of the social influences of partners/fathers of baby (FOB) on their cannabis use during pregnancy; this included bidirectional influences (leading to more/continued or less/discontinuation of cannabis use)
Influence of PCU on relationships	Participants' descriptions of how their cannabis use – or changes to their use – during pregnancy changed the dynamics of their relationships

Healthcare providers	Participants' descriptions of interactions with healthcare providers around their cannabis use
Social norms	Participants' descriptions of social norms around cannabis use
Stigma/discrimination	Participants' descriptions of stigma or discrimination they've experienced due to their cannabis use
<b>Theme 5: "They assume you're gonna look into the details yourself." Frustration with information and support gap</b>	
Code	Definition
Retail environment	Participants' descriptions of changes to the retail environment, noting cannabinoid hemp products, product placement, and lack of warnings on products
Policy environment	Participants' descriptions of the cannabis policy environment in Wisconsin
Accessible information	Participants' descriptions of lack of public education and the desire for accessible information
Advertising	Participants' descriptions of the influence of advertisements on PCU, both in the digital space and in physical spaces (vape shops, gas stations, etc)

## **CURRICULUM VITAE**

Kristine Alaniz, MPH, PhD

### EDUCATION

#### **Ph.D. in Public Health: Community and Behavioral Health Promotion (December 2024)**

Joseph J. Zilber College of Public Health, University of Wisconsin – Milwaukee

Dissertation: Multi-dimensional influences on prenatal cannabis use: A mixed methods study

#### **Graduate Certificate in Maternal and Child Health (May 2023)**

Joseph J. Zilber College of Public Health, University of Wisconsin – Milwaukee

#### **Master of Public Health: Community Health Education (May 2005)**

University of Wisconsin – La Crosse

Thesis: Sexuality and Family Planning Knowledge, Attitudes, and Behaviors of Nicaraguan Youth

#### **Bachelor of Science (December 2002)**

University of Wisconsin – Stevens Point

### AWARDS & SCHOLARSHIPS

#### **Maternal and Child Health Catalyst Scholarship (2023)**

Joseph J. Zilber College of Public Health, University of Wisconsin – Milwaukee

#### **Chancellor's Graduate Student Award in Public Health (2022)**

University of Wisconsin – Milwaukee

#### **Jerry & Louise Stein Scholarship (2020)**

University of Wisconsin – Milwaukee

#### **Graduate Student Achievement Award (2005)**

University of Wisconsin – La Crosse

#### **Outstanding Senior in Health Promotion Award (2002)**

University of Wisconsin – Stevens Point

### TEACHING EXPERIENCE

#### **Public Health (PH) 727: Public Health Planning and Implementation**

Spring 2024

Graduate course; combined MPH and PhD students

## **Biomedical Sciences (BMS) 201: Sexual Transmitted Infections and HIV/AIDS**

Spring 2022, Spring 2023, Spring 2024

Undergraduate course; GER (General Education Requirements)

### SELECTED PROFESSIONAL EXPERIENCE

#### **Maternal and Child Health Epidemiologist/Evaluator – Advanced (LTE) 2024 - Current**

Wisconsin Department of Health Services

- Co-led the design and implementation of statewide needs assessment for the Wisconsin Title V Maternal and Child Health Program
- Collected, monitored, analyzed, synthesized, and reported on qualitative and quantitative data
- Utilized collaborative approaches to prioritize and center the voices of community members, especially those from communities that have been historically and systematically oppressed

#### **Research & Evaluation Assistant 2022 - 2024**

Zilber College of Public Health, University of Wisconsin – Milwaukee, Milwaukee, Wisconsin

- Designed, implemented, and monitored a mixed methods evaluation for Lead-Free Families, a community-driven lead poisoning prevention, detection, and early intervention program
- Co-developed, tested, and adapted data collection tools and processes, data management systems, and monitoring and reporting processes using the Equitable Evaluation Framework
- Worked closely with community partners to build capacity around data management, monitoring and evaluation, project management, and REDCap
- Analyzed all qualitative and quantitative data
- Prepared and circulated reports for multiple audiences

#### **Director of Programs 2021-2023**

#### **Manager of Maternal and Child Health Programs 2012-2021**

Wisconsin Women’s Health Foundation - Madison, Wisconsin

- Oversaw a portfolio of perinatal and family health research projects and programs; responsible for project and strategic planning, grant seeking/writing, developing and overseeing scopes of work, budget development and monitoring, operational oversight, quality assurance plans, and reporting
- Directed all evaluation efforts, including evaluation planning and design, creating logic models, survey and interview design, writing policies and procedures, quantitative and qualitative data analysis, reporting, and dissemination
- Integrated and prioritized community engagement approaches - such as storytelling, listening sessions, advisory groups, and co-design - into all standard program and agency operations
- Directed recruitment, hiring, training, and evaluation of 20 professional staff
- Oversaw health provider training and technical assistance, reaching 1,000 healthcare providers annually

- Oversaw all direct services reaching 4,500 community members annually
- Built and maintained collaborative relationships with government, academic, non-profit, health system, health payer, social service, community, and faith-based partners

**Environmental Health Specialist, Healthy Homes Research Project** **2009-2012**

City of Milwaukee Health Department - Milwaukee, Wisconsin

- Collaborated with research partners, property owners, building inspectors, healthcare providers, and community coalitions to implement a HUD-funded research study for children with uncontrolled asthma
- Conducted home allergen sampling, interpreted results, and communicated results to families
- Worked with families and property owners to identify and mitigate home and community asthma triggers, lead hazards, and safety hazards

**Health Management Advisor** **2007-2009**

Vanuatu Ministry of Health – Port Vila, Vanuatu

- Provided capacity building, training, and technical support to twenty rural health facilities participating in Village Health Worker and Maternal Child Health peer education programs
- Partnered with ten rural communities to apply for and secure funding for water and sanitation funds through United Nations and European Union grants
- Trained and supported a team of Provincial Health Officers on strategic planning, performance measurement, workforce development, budgeting, and grant writing/management
- Developed and executed gender and development (GAD) trainings and initiatives at the community, government, and chiefly system levels

**Communicable Disease Specialist** **2006-2007**

City of Milwaukee Health Department - Milwaukee, Wisconsin

- Provided HIV/STI training and technical assistance to healthcare providers throughout Milwaukee
- Provided one-on-one contact tracing, risk reduction counseling, and testing services to HIV/STI-affected individuals, with a particular focus on pregnant adolescents and their partners

**HIV/STI Prevention Specialist** **2005-2006**

Vivent Health (formerly AIDS Resource Center of Wisconsin) - La Crosse, Wisconsin

- Coordinated a five-county prevention program, which included peer education initiatives, community- and school-based sexual health education, HIV Counseling, testing and referral (CTR) services, clean needle exchange, and Hepatitis A and B vaccination services
- Recruited, trained, and supervised up to 20 peer educators, interns, and volunteers

## PUBLICATIONS

Mundt P, Fiore M, Piper M, Adsit, R, Kobinski K, **Alaniz K**, Baker T (2022). Cost-effectiveness of stop smoking incentives for Medicaid-enrolled pregnant women. *Preventive Medicine*, 153.

**Alaniz K**, Christiansen B, Sullivan T, Khalil L, Fiore MC (2019). Helping low-income pregnant women quit smoking: improving the First Breath program. *Wisconsin Medical Journal*, 188 (3).

**Alaniz K**, Christiansen B, Sullivan T, Khalil L, Fiore MC (2019). Addressing postpartum smoking relapse among low-income women: a randomized control trial. *J Patient Cent Res Rev* (6), 233-242.

Baker T, Fraser D, Kobinsky K, Adsit R, Smith SS, Khalil L, **Alaniz K**, Sullivan T, Johnson M, Fiore M (2018). A randomized controlled trial of financial incentives to low-income pregnant women to engage in smoking cessation treatment: Effects on post-birth abstinence. *J Consult Clin Psychol*. 86(5), 464-473.

## PROFESSIONAL PRESENTATIONS, SPEAKING ENGAGEMENTS, AND POSTERS

### **Psychosocial Influences on Tobacco-Alcohol Co-Use During Pregnancy (2024)**

Oral presentation, CityMaTCH Conference

### **Multi-level Influences on Perinatal Cannabis Use: An Integrative Review (2024)**

Oral presentation (virtual), CannAct Conference

### **Smoke-free After Baby: Psychosocial Predictors of Postpartum Abstinence (2023)**

Poster presentation, American Public Health Association

### **Quality Measurement and Improvement State Story: First Breath (2022)**

Invited speaker, Medicaid & CHIP Healthcare Quality Measurement and Improvement's State Stories Series

### **The Impact of Cannabis on Maternal and Child Health (2021)**

Oral presentation, Wisconsin Public Health Association – Public Health in Practice Conference

### **The Impact of Cannabis on Maternal and Child Health (2021)**

Oral presentation, Wisconsin Association for Perinatal Care Conference

### **Introducing Wisconsin's Mental Health Resource Navigator for Children and Youth (2021)**

Oral presentation, Wisconsin Adolescent Health Symposium

**First Breath: A CFIR Case Study (2020)**

Oral presentation, University of Wisconsin Madison - Institute for Clinical and Translational Research's Dissemination and Implementation Short Course

**Perspectives on Substance Use During Pregnancy & Breastfeeding (2020)**

Poster presentation, Wisconsin Association for Perinatal Care

**Addressing Tobacco Use Among High-Risk Pregnant and Postpartum Women (2019)**

Invited speaker, Centers for Disease Control and Prevention Self-Made Health Network Series

**Addressing Postpartum Relapse Among Low-Income Women (2019)**

Oral presentation, National Conference on Tobacco or Health

**A Pilot Study Addressing Postpartum Relapse (2019)**

Poster presentation, Society for Research on Nicotine and Tobacco Conference

**Expanded Tobacco Programming for Healthy Birth Outcomes (2017)**

Invited speaker, National Infant Mortality Collaborative, and Innovation Network

**High-Risk Smokers Speak: A Qualitative Study of Low-Income Pregnant Smokers (2017)**

Oral presentation, Wisconsin Association for Perinatal Care

**Innovative Practices for Reducing Maternal Smoking (2015)**

Poster presentation, National Conference on Tackling Tobacco Use in Vulnerable Populations

**CURRENT COMMUNITY AND PROFESSIONAL MEMBERSHIPS**

Coalition on Lead Emergency (2021-Current)

American Public Health Association (2023 – Current)

Student Advocates for Maternal and Child Health Equity, UW – Milwaukee (2021 – Current)

American Evaluation Association (2019 – Current)