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POLYSUBSTANCE OPIOID USE IN A JUSTICE-INVOLVED POPULATION: AN ANALYSIS OF PATTERNS AND REENTRY OUTCOMES

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POLYSUBSTANCE OPIOID USE IN A JUSTICE-INVOLVED POPULATION: AN ANALYSIS OF PATTERNS AND REENTRY OUTCOMES

DISSERTATION

A dissertation submitted in partial fulfillment of the
requirements for the degree of Doctor of Philosophy in the
College of Arts & Sciences
at the University of Kentucky

By

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Lexington, Kentucky

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ABSTRACT OF DISSERTATION

POLYSUBSTANCE OPIOID USE IN A JUSTICE-INVOLVED POPULATION: AN ANALYSIS OF PATTERNS AND REENTRY OUTCOMES

The public health crisis surrounding opioid use is pronounced among justice-involved populations, who face high rates of overdose mortality as well as HIV, and hepatitis C due to injection drug use. The majority of opioid-related overdoses are due to polysubstance use (PSU), and a better understanding of the prevalence and patterns of PSU are necessary in order to inform interventions. This dissertation project has three aims: (1) understand the patterns of opioid PSU among a justice-involved population, (2) identify PSU patterns most at-risk for post-release relapse, and (3) examine engagement in post-release health service utilization. Post-release aims are guided by the Gelberg Behavioral Model of Vulnerable Populations.

This project utilizes secondary data from the Criminal Justice Kentucky Treatment Outcome Study, a Kentucky Department of Corrections funded two-wave longitudinal study of individuals who participated in substance abuse treatment programming while incarcerated. Latent profile analysis is used to determine the patterns of pre-incarceration opioid PSU in aim 1. Analyses for aims 2 and 3 examine PSU profiles, along with variables drawn from the Behavioral Model for Vulnerable Populations, in order to predict important reentry outcomes of relapse and health service utilization 12-months post-release in a series of logistic regressions.

Six unique profiles of opioid PSU were found among the current justice-involved population, which faced disproportionate risk of adverse outcomes at follow-up. Findings indicate heterogeneity of opioid use among a justice-involved population. The role of mental and physical health in PSU severity is also highlighted. Further, results from post-release analyses indicate that a continuum of risk exists among PSU such that PSU patterns are unique and important predictors of post-release outcomes which can be used to inform interventions during incarceration. The importance of accounting for vulnerability as conceptualized in the Behavioral Model for Vulnerable Populations is also discussed.

KEYWORDS: opioid use, polysubstance use, criminal justice, relapse, emergency room

Amanda Marie Bunting

April 9, 2019

POLYSUBSTANCE OPIOID USE IN A JUSTICE-INVOLVED POPULATION: AN ANALYSIS OF PATTERNS AND REENTRY OUTCOMES

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DEDICATION

To *Minnie*

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CHAPTER 1. BACKGROUND AND INTRODUCTION

1.1 Introduction to topic

The opioid epidemic has taken an excess of 700,000 lives since 1999 (CDC, 2018). Overdose deaths due to opioids continue to increase, with opioids involved in 67.8% of all overdose deaths in 2017 (CDC, 2018). One in 10 individuals who died from an overdose were recently released from a criminal justice institution (Mattson, 2018). Recent data suggest the majority of individuals with opioid use disorders have recent justice involvement (Winkelman, Chang, & Binswanger, 2018). Complicating this issue is the involvement of multiple substances, known as polysubstance use (PSU), and the subsequent involvement of PSU in overdose fatalities.

This dissertation research examines pre-incarceration patterns of opioid PSU in order to advance understandings of PSU among justice populations. The advanced statistical approach of latent profile modeling is utilized to provide insights into the severity of PSU among the current population. Further, the utility of pre-incarceration PSU opioid patterns as predictors of post-release behaviors is examined.

Deaths due to overdose from prescription opiates (PO) have increased since the 1990s, but trends indicate the increase is not due to an increasing number of users (Kandel, Hu, Griesler, & Wall, 2017). Rather, the prevalence of PSU with PO use has increased (Kandel et al., 2017). Over a twelve-year period, the prevalence of PSU related overdoses with PO increased from 44% to 58% (Kandel et al., 2017). Deaths due to PO in combination with heroin tripled and deaths in combination with benzodiazepines and alcohol increased by a factor of 1.7 and 1.6 respectively (Kandel et al., 2017).

PSU is incredibly dangerous. For example, co-use of benzodiazepines and opioids decreases oxygen saturation leading to respiratory depression (Darke, 2014). Despite the

increased risk for overdose, the regular co-use of benzodiazepines and opioids is common. The rate of co-use of benzodiazepines is approximately 70% among users of heroin as well as methadone-maintenance and buprenorphine-maintenance patients (Jones et al., 2012). The combined use of opioids and cocaine is lethal as well, often due to the fact that the combination delays the effects of opioids causing individuals to believe they can consume increased and ultimately deadly amounts (Guzman & Ettenberg, 2004; Leri, Bruneau, & Stewart, 2003).

The most recent data available from CDC indicates that 18.5% of opioid deaths involved both PO and illicit opioids (Mattson, 2018). Further PSU includes co-use of benzodiazepines (44%) and cocaine (35%) with PO and illicit opioids (Mattson, 2018). An increasing number of overdose deaths are due to synthetic opioids, primarily illicit fentanyl (Jones, Einstein, & Compton, 2018). Deaths from synthetic opioids increased from 14% in 2010 to 46% in 2016, with 80% of these deaths involving another substance such as other opioids, cocaine, benzodiazepines, or alcohol (Jones et al., 2018).

Among individuals who use heroin, PSU is common, such that 96% of users report using at least one other substance and 61% report using at least three different substances, including meeting the criteria for abuse or dependence for more than one substance (Jones, Logan, Gladden, & Bohm, 2015). PSU is also common among individuals who illicitly use methadone and buprenorphine, such that individuals who engage in PSU may be more likely to divert opioid substitution therapies (Bretteville-Jensen, Lillehagen, Gjersing, & Andreas, 2015).

Motivations for PSU likely differ by substances and by PSU method. PSU ingestion can occur simultaneously, sequentially, or via regular interval co-use. The combination of two or more substances during simultaneous PSU may produce unique or preferred effects that each drug does not create individually or serve a particular purpose as in the case of self-medication (Leri et al., 2003). For example, simultaneous PSU of heroin and methamphetamine (frequently referred to as “goofballs”) has been increasing over the past decade (Al-Tayyib, Koester,

Langegger, & Raville, 2017) with some reporting that the combination intensifies the effect of low-purity heroin (Meacham et al., 2016).

Sequential PSU is similar to, yet unique from, simultaneous PSU. Motivations for sequential use (i.e., use of one substance followed by another) can include aversion, the use of one substance serves to reduce negative symptoms of the other- or reinforcing. For example, sequential use of heroin and cocaine is stated to produce a more rewarding "high." Sequential use of heroin and cocaine is associated with injection drug use (IDU) risk practices such as front-loading and back-loading (Auerbach, Wypijewska, & Brodie, 1994). Additional research indicates that heroin and sequential cocaine PSU eases withdrawal symptoms when opioid effects terminate (Leri et al., 2003).

Regular interval PSU varies greatly and can be motivated by reinforcement, aversion, or dependence. As an example, individuals may use stimulants in the morning or throughout the week to stimulate their mood and productivity yet use sedatives in the evenings to "come down" or relax (Ellinwood, Eibergen, & Kilbey, 1976). Regular interval PSU increases likelihood of multiple substance use dependencies (Ellinwood et al., 1976; J. D. Jones, Mogali, & Comer, 2012) as well as adverse outcomes such as overdose (Jones et al., 2012). Regular interval use of benzodiazepines with opioids can be motivated by the reinforcing effects by which benzodiazepines amplify opioid intoxication (Chen et al., 2011; Jones et al., 2012).

Common PSU patterns of returning citizens associated with elevated risk for overdose include opioids and cocaine as well as cocaine and other narcotics (Binswanger et al., 2013). The most recent data suggest that 58% of state prisoners and 63% of jail inmates meet criteria for drug dependence or abuse, compared with only 5% of the general population (Bronson, Stroop, Zimmer, & Berzofsky, 2017). Studies have found 30-74% of currently incarcerated individuals report using more than one substance prior to incarceration (Kubiak, 2004; Lo & Stephens, 2000).

For individuals leaving the justice system, the reentry period is one of increased overdose risk (Binswanger et al., 2012). Risk of overdose is highest in the initial weeks post-release owing to reduced tolerance following periods of abstinence, and opioids were found to be involved in 59% of overdoses in one recently released sample (Binswanger, Blatchford, Mueller, & Stern, 2013). Among the same formerly justice-involved sample, 56% had more than one substance involved in their overdose indicating substantial PSU prevalence. Despite risk, justice-involved populations represent a vulnerable population whose PSU prevalence and patterns have yet to be fully understood.

1.1.1 What we know and the utility of latent variable analysis

It is important to understand PSU given the associated risks, yet studying the topic is not necessarily straightforward owing to the multiple modes of consumption and possible combinations of substances involved. Statistical techniques such as cluster modeling and latent class analysis have emerged as ideally suited to analyze PSU given their inductive approach. Latent class analyses are person-centered approaches, used to create subgroups known as classes- - or profiles in the case of continuous indicator variables- based on patterns from the data (Collins & Lanza, 2010). In these analyses, individual characteristics, such as PSU patterns and preferences, are central to the investigation compared to variable centered approaches (e.g., factor analysis) where the structure is assumed to hold for all individuals (Collins & Lanza, 2010). When dichotomous or ordinal indicators are used, latent class analysis (LCA) is performed while latent profile analysis (LPA) uses continuous indicators. As an example, classes created from LCA would include several substance indicators (yes/no) if an individual reported previous 30-day use. For LPA, the number of days an individual used each substance would be used to create the profiles.

It is advantageous to utilize LCA/LPA techniques for exploring the topic of PSU as it allows the heterogeneity of substance patterns to be revealed inductively, as opposed to the

researcher deciding which patterns should exist and deductively imposing them. The method has grown in popularity among researchers of PSU (e.g., Agrawal, Lynskey, Madden, Bucholz, & Heath, 2007; Betts et al., 2015; Harrell, Mancha, Petras, Trenz, & Latimer, 2012; Trenz et al., 2013; Wu et al., 2011). Due to the high rate of overdose deaths in the current opioid epidemic, it is important to highlight what existing understandings of opioid-PSU exist.

Given the utility of LCA/LPA to understand PSU, a systematic review of relevant studies was conducted. EBSCOhost was searched using the keywords "latent (class) analysis" AND "substance use" AND prefix "opi." The resulting list was 44 studies, excluding duplicates. Articles were also identified through secondary sources (i.e., searching reference lists of included articles).

Inclusion criteria included (1) population of interest: adults (adolescents and college students were excluded), (2) substance use measurement: substance use must be self-report or measured based on actual behaviors as opposed to studies relying on DSM criteria (3) publication status: peer-reviewed primary studies only (commentaries and other such publications were excluded), (4) method: the primary method must be a form of latent class analysis, (5) language: all studies had to be published in English. The final resulting sample was 22 studies (see Table 1).

The 22 studies varied greatly in terms of populations included, and many of the studies were in other countries, including Australia (n=5; Betts et al., 2016; Connor et al., 2013; Kelly et al., 2014; Nielsen et al., 2011; Quek et al., 2013), South Africa (n= 1; Trenz et al., 2013), the United Kingdom (n=2; Melendez-Torres, Bourne, Hickson, Reid, & Weatherburn, 2018), Norway (n=1; Gjersing & Bretteville-Jensen, 2018), Spain (n=1; Fernández-Calderón et al., 2017), and Canada (n=2; Patra, Fischer, Maksimowska, & Rehm, 2009; Roy, Richer, Arruda, Vandermeerschen, & Bruneau, 2013). Thus, the majority of prior studies have examined opioid PSU in other countries; further understandings of PSU in a U.S. population, given the complex opioid epidemic unique to the United States, is warranted.

The LCA indicators varied significantly across studies (see Table 1). Substance use histories varied in terms of time-span measured, ranging from lifetime use (Wu et al., 2011) to prior 30-day use (Connor et al., 2013; Fong, Matusow, Cleland, & Rosenblum, 2015; Green, Black, Serrano, Budman, & Butler, 2011; Harrell et al., 2012; Morley, Lynskey, Moran, Borschmann, & Winstock, 2015; Parsons, Starks, Millar, Boonrai, & Marcotte, 2014; Patra et al., 2009). Further, studies varied in latent indicators included for latent class construction. Studies asked respondents about use of single substances, use of specific combinations (e.g., speedball use), and others were more specific and account for route of administration (e.g., inject heroin). The fewest latent indicators used for class creation were six substances (Ramo, Grov, Delucchi, Kelly, & Parsons, 2010) and sixteen substances were the greatest number of indicators used (Betts et al., 2015; Patra et al., 2009). While one study focused on substances by specific brand name (Patra et al., 2009), the majority were concerned with broader categories (e.g., tranquilizers) to capture a wider range of substance-use behaviors.

Studies varied in operationalization of indicators as well. The majority (82%) relied on dichotomous measurements of use to construct classes. These range from collapsed ordinal measures (e.g., frequent use versus infrequent) to simple yes/no indicators. Three studies used ordinal indicators measuring frequency of use to construct classes (Betts et al., 2015; Feaster et al., 2016; Gjersing & Bretteville-Jensen, 2018). Only one of the studies utilized a continuous count of days used (Parsons et al., 2014).

The resulting latent classes indicate that patterns vary substantially, owing to latent class construction. However, there are some similarities to note. Most notably is the existence of opioid-stimulant classes. Predominately these classes include cocaine and heroin use patterns (Harrell et al., 2012; Kuramoto, Bohnert, & Latkin, 2011; Meacham et al., 2015; Patra et al., 2009; Roy et al., 2013). Additionally, while the patterns of use may vary due to inclusion, all

latent results have a class that is categorized by diverse substance use (i.e., heterogenous PSU) and more extensive substance use than other classes.

The current composition of opioid LCA studies reveals important information, critical to the studies of PSU. However, two issues remain. First, the implications of PSU are not entirely clear. While the majority of studies examine prior 30-day use, an indicator more likely to accurately reflect PSU patterns, other studies utilize dichotomous indicators over several months, yearly, or lifetime time-spans. While even one instance of PSU can be dangerous, it remains unclear if studies measuring multi-month, yearly, or lifetime indicators of substance use are accurately capturing PSU patterns. For example, if an individual used marijuana three months ago but drank alcohol last week, are they truly an at-risk polysubstance user? Studies examining prior 30-day use of multiple substances are more likely capturing the public health concern of PSU. Further, studies that dichotomize ordinal indicators (e.g., more than once a week versus all other use) are more apt to capture riskier PSU patterns. The next step for PSU studies would be to include continuous indicators for LPA, to more accurately understand the likelihood of overlapping substance use within a month for an individual. Studies that include variables specific to PSU, such as measuring popular drug combinations, are also beneficial. However, for studies of PSU to advance long-term, construction of PSU-specific screening and assessment tools will need to be adapted.

The second limitation is the lack of justice-involved populations and justice covariates among opioid PSU LCA studies. Of the studies included in Table 1, only two included any account of justice involvement. Betts et al. (2016) and Green et al. (2011) included variables of justice involvement and examined association of classes with justice variables. Results indicate that more severe PSU classes had higher likelihood of justice involvement. Owing to sampling techniques it is likely that many of the studies included formerly justice-involved populations.

Explicit consideration through covariates or examination of PSU patterns among justice populations, given their higher prevalence of substance use, is warranted.

The current research addresses these limitations by utilizing 30-day continuous indicators of substance use to examine the polysubstance opioid patterns of a justice-involved sample. Measures of substance use in the 30-days prior to incarceration are used in latent profile creation in order to reveal PSU patterns that are expected to be more severe, given the substance use histories of justice-involved populations.

1.1.2 Justice-involved populations as a vulnerable population

Many of the significant associations of PSU are more prevalent in justice-involved populations, placing this population at disproportionate risk. Similar to PSU individuals, justice-involved individuals are more likely to have lower levels of education and complex histories of physical and mental health problems (Shane Darke & Hall, 1995; Harlow, 2003; James & Glaze, 2006; Mallik-Kane & Visher, 2008; Martinotti et al., 2009).

A greater number of mental health comorbidities is associated with increasing number of substances used (Borges, Walters, & Kessler, 2000; Connor et al., 2013; S. Darke & Ross, 1997; Hakansson, Schlyter, & Berglund, 2011; Wu et al., 2011). Since mental health disorders are more common among justice-involved individuals (James & Glaze, 2006), the relationship of PSU with mental health comorbidity may be even more pronounced among this population. The same is true of physical health comorbidities such that both tend to be poorer among PSU and justice-involved populations (Carlson et al., 2014; Feaster et al., 2016; Mallik-Kane & Visher, 2008; Patra et al., 2009; Quek et al., 2013). There are also significant associations of certain PSU patterns with IDU and hepatitis C (Harrell et al., 2012; Monga et al., 2007; Patra et al., 2009; Roth et al., 2015).

Co-occurring mental health psychopathology and physical health comorbidities also complicate the reentry process. Approximately three-quarters of justice-involved individuals with a mental health problem have co-morbid substance dependence or abuse (James & Glaze, 2006). Individuals with depression, anxiety, and other mental health conditions may return to substance use post-release for complex reasons including self-medication (Binswanger et al., 2012; Hser, 2007) and disruption to mental health medications post-release (Binswanger et al., 2012).

Justice-involved populations have poorer health than general populations (Freudenberg, 2001). Greater than 1/3 of individuals in prisons and jails have a chronic medical condition (Wilper et al., 2009), including higher likelihood of conditions such as hypertension asthma, cervical cancer, and hepatitis (Binswanger, Krueger, & Steiner, 2009). Further, continuity of care upon reentry is difficult to manage due to the complexities in finding employment and housing, lack of social support, difficulties obtaining insurance, and lack of social services (Mallik-Kane & Visher, 2008; Petersilia 2008). Overall, the reentry period is a complicated one for individuals returning to the community. Individuals with substance use histories, and PSU histories, are likely to experience barriers in their attempts to avoid post-release substance use and appropriately manage comorbid conditions.

Pronounced health problems are further difficult to manage post-release when unemployment and economic distress are considered. Justice system involvement is concentrated in the most disadvantaged communities (Western, 2014). The majority of individuals enter prisons and jails with significant economic hardship, including 1 in 7 individuals with a substance use disorder reporting pre-incarceration homelessness (Mumola & Karberg, 2006). Pre-treatment unemployment is extremely common among individuals who use opioids (Platt, 1995.). While employment has been demonstrated to be an important protective factor against relapse (Evans, Hahn, Lum, Stein, & Page, 2009; Kadam, Sinha, Nimkar, Matcheswalla, & De Sousa, 2017; Steensma, Boivin, Blais, & Roy, 2005) and recidivism (Apel & Horney, 2017; Bunting et al.,

2019), there are significant barriers to successful employment for individuals who are reentering the community. It is difficult to focus on recovery and health when faced with the competing needs of general welfare.

1.2 Dissertation Research

Research is needed to understand the PSU patterns and prevalence among justice-involved samples. While research of justice-involved populations indicate that this population has increased risk factors and likelihood for PSU, the patterns of PSU among justice-involved populations are unclear. While LCA research has identified possible PSU patterns among general (e.g., Carlson et al., 2014; Quek et al., 2013) and at-risk populations (e.g., Kuramoto et al., 2011; Meacham et al., 2016), justice populations have been excluded from research thus far.

The dissertation research is also interested in two important reentry outcomes related to health of justice populations. Given that post-release substance use complicates reentry processes, understanding the pre-prison PSU patterns and the subsequent post-release effects of these patterns will reveal insights to inform future interventions. Substance use is typically highest during periods of offending (Fisher et al., 2014), and involvement with the justice system provides a key point for intervention. Further, previous research indicates the likelihood that PSU populations have poorer health and are more likely to have comorbid physical and mental health conditions (Betts et al., 2015; Shane Darke & Hall, 1995; James & Glaze, 2006; Mallik-Kane & Visher, 2008). Ensuring these populations have appropriate linkage to health services post-release and understanding barriers to care is additionally important. Pre-incarceration PSU patterns' predictive value of post-release health service utilization can facilitate reentry planning.

To that end, this dissertation aims to expand on previous research through three contributions:

(1) Understanding the prevalence and patterns of PSU among a justice-involved sample,

(2) Examining the association of PSU patterns with post-release behaviors, and

(3) Improving upon existing methodologies through the utilization of LPA and continuous substance use indicators

Through completion of these goals, the dissertation provides the foundation for a trajectory of PSU research. By increasing knowledge of the intersection of PSU and justice-involvement, including relevant methodologies with which to study the phenomena, the dissertation provides the framework for the next phase of research aimed at development of screening and assessment tools specifically created to capture PSU patterns.

1.2.1 Research Questions

The dissertation uses a three-paper format to address the following topics:

Chapter 2, "Paper 1: Heterogenous Opioid Use Among Justice-Involved Individuals: A Latent Profile Analysis of Pre-Incarceration Polysubstance Opioid Use," uses latent profile analysis to answer the following research questions:

RQ1: What are the pre-incarceration polysubstance opioid patterns of a justice-involved population in Kentucky?

RQ1.1: How are polysubstance opioid profiles of a justice-involved sample associated with various sociodemographic, mental and physical health, and criminal justice histories?

It is hypothesized that polysubstance profiles of a justice-involved sample will have similarities to general population PSU, yet be unique in terms of (1) severity or (2) new emerging profiles. Further, relevant associations are likely to yield similarities to general populations, while likely being more pronounced due to the likelihood of PSU populations to be represented by characteristics that are inherent to justice-involved populations (e.g., mental health comorbidities).

Chapter 3, “Paper 2: Return to Substance Use: A Post-Release Examination of Polysubstance Use,” utilizes logistic regression of baseline and follow-up data to address the following research question:

RQ2: Which polysubstance profiles are at increased risk for post-release relapse?

It is expected that profiles with diverse PSU (i.e., more substances used, higher PSU) will be at increased risk for relapse, given the association of these profiles for justice-involvement in general populations.

Chapter 4, “Paper 3: Post-Release Health Service Utilization: An Application of the Behavioral Model of Vulnerable Populations to a Polysubstance Population,” examines health service utilization post-release through logistic block models to answer the following question:

RQ3: Which polysubstance profiles engage in post-release health care?

More diverse PSU patterns are associated with poorer physical and mental health, but how this relates to consumption of services is unclear. It is hypothesized, therefore, that those profiles shown in paper 1 (Chapter 2) to have the poorest health will be more likely to consume various post-release care services simply due to increased need.

Chapter 5 will provide an overview of findings, consideration of all papers (1-3) collectively, implications for interventions and policy, as well as directions for future research.

1.2.2 Description of data

Data for the three papers are from the state-mandated treatment outcome study of substance abuse programming called the Criminal Justice Kentucky Treatment Outcome Study. The study is ongoing since 2005 through a collaboration with the KY Department of Corrections and the University of Kentucky’s Center on Drug and Alcohol Research.

Data include both baseline assessments (Chapter 2) and follow-up surveys (Chapters 3 & 4). Baseline assessments are completed upon intake to substance abuse programming while follow-up surveys occur 12-months post-release. Detailed information regarding the study, sampling, and inclusion criteria are included in appropriate sections of each paper.

1.2.3 Covariate selection guided by the Behavioral Model for Vulnerable Populations

In Chapters 3 and 4 examining post-release health behaviors and health services utilization, covariate selection is guided by the Behavioral Model for Vulnerable Populations (Gelberg, Andersen, & Leake, 2000). A prior Behavioral Model by Andersen (1995) was expanded to include factors specific to vulnerable populations, identified as those who experience a greater risk of poor health due to differential exposure to risk factors. The framework identifies characteristics that lead to health service utilization or health behaviors in the three domains of (1) predisposing factors, (2) enabling factors, and (3) need factors which are further dichotomized into categories based on relevancy to (1) traditional or (2) vulnerable populations. A diagram is provided in Chapter 3 (paper 2) and Chapter 4 (paper 3).

Predisposing factors include demographic characteristics, or factors that exist prior to a health need. Traditional predisposing factors include age, race, gender, marital status, or employment. Vulnerable predisposing factors include homelessness (housing status), incarceration history, or childhood characteristics (e.g., foster home history).

Enabling factors include resource characteristics, or those which affect one's ability to secure resources or care. In the traditional domain, this would include variables such as insurance status or social support. In the vulnerable domain, variables could include public benefit receipt, community resources, or disability status.

Need factors are the health conditions of general (for traditional) or specific vulnerable populations. Traditional need factors would include general health problems whereas vulnerable

need factors would be specified to the population studied, such as human immunodeficiency virus (HIV) or sexually transmitted diseases.

Previous research has examined the Behavioral Model for Vulnerable Populations among incarcerated populations (Glover, 2017; Krishnan et al, 2013; Meyer e al., 2012; Oser et al., 2016; Victor et al., 2017) and found the vulnerable domains to be robust predictors of health service utilization. These studies are generally limited to specific subpopulations, such as previously incarcerated women or individuals with HIV, thus lacking a broader focus on reentering populations more broadly. Recently released persons who use opioids are a vulnerable population with greater risk of poor outcomes and exposure to risk factors. To account for this, covariate selection and a secondary aim of examining the relevance of the vulnerable domain in predicting post-release relapse and service utilization was included in papers 2 and 3. Further discussion of the framework is included in the relevant section of these papers.

Table 1.1Overview of the 22 studies included in the review

Citation	Sample Population	Latent indicators	Frequency of use	Measurement	Results- latent classes
Betts, K. S., Chan, G., McIlwraith, F., Dietze, P., Whittaker, E., Burns, L., & Alati, R. (2016). Differences in polysubstance use patterns and drug-related outcomes between people who inject drugs receiving and not receiving opioid substitution therapies. *Addiction*, *111*(7), 1214–1223.	Australia, SEP convenience sample as part of Illicit Drug Reporting System (2011-2013 combined) N=2,677	heroin, methamphetamine, cocaine, cannabis, methadone, buprenorphine, buprenorphine-naloxone, morphine, oxycodone, other Rx opioids, quetiapine, alprazolam, other benzodiazepines, prescription stimulants, over the counter opioids, alcohol	Previous 5 months	Ordinal from daily to less than monthly (4 intervals)	(1) methadone/heroin, low PSU (2) methadone/heroin high PSU (3) buprenorphine/heroin, low PSU (4) methadone, moderate PSU (5) high PSU (6) high heroin (7) high morphine (8) high methamphetamines stratified by OST vs non-OST
Carlson, R. G., Nahhas, R. W., Daniulaityte, R., Martins, S. S., Li, L., & Falck, R. (2014). Latent class analysis of non-opioid dependent illegal pharmaceutical opioid users in Ohio. *Drug and Alcohol Dependence*, *134*, 259-266.	US, respondent driven sampling in Ohio N=390	NMPR, number of opioid abuse and dependence criteria, oral vs non-oral, number of types of opioids, use of alcohol or tranquilizers, reason for opioid use	Prior 6-month use	Dichotomous with the exception of indicator “reason for use” (3 nominal categories)	Classes not given descriptor names, NW-1 NW-2 NW-3 W-1 W-2 W-3 stratified by race such that NW=non-white W=white and numbers 1-3 indicating most to least negative patter of opioid use
Connor, J. P., Gullo, M. J., Chan, G., Young, R. M., Hall, W. D., & Feeney, G. F. X. (2013).	Australia, individuals	cannabis, tobacco, alcohol, amphetamine,	Prior 30-day use	Dichotomous	(1) wide ranging substance use (2)

Polysubstance Use in Cannabis Users Referred for Treatment: Drug Use Profiles, Psychiatric Comorbidity and Cannabis-Related Beliefs. *Frontiers in Psychiatry*, *4*, 79. doi: 10.3389/fpsyt.2013.00079	referred to Queensland Illicit Drug Diversion Initiative N=827	ecstasy, heroin, benzodiazepines			cannabis alcohol and tobacco (3) cannabis and alcohol
Feaster, D. J., Parish, C. L., Gooden, L., Matheson, T., Castellon, P. C., Duan, R., … Metsch, L. R. (2016). Substance Use and STI Acquisition: Secondary Analysis from the AWARE Study. *Drug and Alcohol Dependence*, *169*, 171–179.	US, Project AWARE STI clinics in 9 cities N= 5,012	amphetamines, cocaine, MDMA, ketamine, GHB and inhalants, heroin and pain pills, hallucinogens, PCP, tranquilizers/barbiturates, and marijuana	Prior 6-month use	Ordinal ranging from none to daily (6 intervals)	(1) low use (2) mostly marijuana (3) sever club (4) severe street use stratified by sex behavior groups (e.g., men who have sex with men)
Fernández-Calderón, F., Blanco-Rodríguez, M., Martín-Cazorla, F., Martínez-Téllez, I., Soriano-Ramón, T., & Bilbao-Acedos, I. (2017). Drug-induced deaths in Southern Spain: profiles and associated characteristics. *Journal of Substance Use*, *22*(3), 289–294.	Spain, Toxicology reports N=360	methadone, benzodiazepines, opiates, cocaine, alcohol, cannabis, other substances	Drugs involved in death	Dichotomous	(1) methadone-benzodiazepines (2) cocaine (3) benzodiazepines-cocaine-methadone-opiates (4) benzodiazepines-alcohol
Fong, C., Matusow, H., Cleland, C. M., & Rosenblum, A. (2015). Characteristics of Non-Opioid Substance Misusers Among Patients Enrolling in Opioid Treatment Programs: A Latent Class Analysis. *Journal of Addictive Diseases*, *34*(2–3), 141–150.	US, 33 state opioid treatment programs N=19,101	Rx opioids, heroin, heavy alcohol use (more than 4 times a day), marijuana, MDMA, cocaine or crack, crystal meth, hallucinogens, anti-anxiety meds, Rx sleep meds, and anti-depressants	Prior 30-day use	Dichotomous	(1) low-use class-largest class (2) non-opioid Rx use (3) marijuana and/or cocaine use (4) polydrug use

Gjersing, L., & Bretteville-Jensen, A. L. (2018). Patterns of substance use and mortality risk in a cohort of 'hard-to-reach' polysubstance users. *Addiction*, *113*(4), 729–739.	Norway, seven cities street recruited or through harm reduction services N=884	heroin, other opioids, Rx drugs (opioids, stimulants, benzodiazepines), amphetamine, cocaine, alcohol and cannabis in 4 weeks previous route of administration	Previous 4 weeks	Ordinal from no use to more than 4 times a week (3 intervals)	Stratified by OST, OST: (1) frequent methadone users (2) frequent buprenorphine uses (3) OST heroin injectors Non-OST: (1) PSU injectors (2) frequent heroin injectors (3) low frequent injectors
Green, T. C., Black, R., Serrano, J. M. G., Budman, S. H., & Butler, S. F. (2011). Typologies of Prescription Opioid Use in a Large Sample of Adults Assessed for Substance Abuse Treatment. *PLOS ONE*, *6*(11), e27244. doi: 10.1371/journal.pone.0027244	US, assessments from Addiction Severity Index-Multimedia Version respondents N=26,314	NMPR of long acting Rx opioid, NMPR of short acting, use by non-medical route, illicit source, chronic health problem, takes Rx for medical problem	Prior 30-day use	Dichotomous	(1) use as prescribed (2) prescribed misusers (3) medically health abusers (4) illicit users
Harrell, P. T., Mancha, B. E., Petras, H., Trenz, R. C., & Latimer, W. W. (2012). Latent classes of heroin and cocaine users predict unique HIV/HCV risk factors. *Drug and Alcohol Dependence*, *122*(3), 220–227.	US, Baltimore NEURO-HIV study N=552	alcohol, cigarettes, injecting speedball, injecting heroin, snorting heroin, injecting cocaine, smoking crack, smoking pot	Prior 30-day use	Dichotomous	(1) Crack/Nasal Heroin users (2) PSU (3) Heroin injectors
Kelly, A. B., Chan, G. C. K., White, A., Saunders, J. B., Baker, P. J., & Connor, J. P. (2014). Is there any evidence of changes in patterns of concurrent drug use among young	Australia, 2010 National Drug Strategy	alcohol, tobacco, marijuana, ecstasy, tranquilizers, cocaine, hallucinogens,	Prior year use	Dichotomous	(1) alcohol only (2) alcohol and tobacco (3) marijuana, ecstasy and another licit drug

Australians 18–29years between 2007 and 2010? *Addictive Behaviors*, *39*(8), 1249–1252.	Household Survey N=3,836	methamphetamine, pain killers			use (4) extended concurrent drug use
Kuramoto, S. J., Bohnert, A. S. B., & Latkin, C. A. (2011). Understanding subtypes of inner-city drug users with a latent class approach. *Drug and Alcohol Dependence*, *118*(2), 237–243.	US, Baltimore SHIELD study N=1,061	drank alcohol, smoked pot, IDU heroin, IDU speedball, IDU cocaine, snort heroin, snort cocaine, smoked crack	Prior 6-month use	Dichotomous	(1) heroin injecting (2) polydrug and polyroute (3) heroin and cocaine IDU (4) heroin snorting (5) crack smoking
Meacham, M. C., Rudolph, A.E., Strathdee S.A., Rusch, M.L., Brouwer, K.C., Patterson, T.L., Vera, A., Rangel, G., Roesch, S.C. (2015). Polydrug use and HIV risk among people who inject heroin in Tijuana, Mexico: A latent class analysis. *Substance Use & Misuse 50*(10), 1351-1359.	Mexico, IDU in Tijuana N=1,025	cocaine IDU, cocaine smoking or snorting, methamphetamine IDU, methamphetamine smoking or snorting	Prior 6-month use	Dichotomous	(1) predominately heroin (2) methamphetamine heroin (3) methamphetamine cocaine heroin
Melendez-Torres, G. J., Bourne, A., Hickson, F., Reid, D., & Weatherburn, P. (2018). Correlates and subgroups of injecting drug use in UK gay and bisexual men: Findings from the 2014 Gay Men's Sex Survey. *Drug and Alcohol Dependence*, *187*, 292–295.	United Kingdom, 2014 Gay Men's Sex Survey N=16,464	IDU use of amphetamine, crystal meth, heroin, mephedrone, GHB, and ketamine	Prior year use	Dichotomous	(1) chemsex IDU-crystal meth and mephedrone (2) opiate IDU- heroin (3) eclectic IDU- high IDU of all drugs
Morley, K. I., Lynskey, M. T., Moran, P., Borschmann, R., & Winstock, A. R. (2015). Polysubstance use, mental health and high-risk behaviours: Results from the 2012 Global Drug Survey. *Drug & Alcohol Review*, *34*(4), 427–437.	UK, Australia, and US Global Drug Survey N=22,289	cannabis, ecstasy, cocaine, stimulants, nitrous, ketamine, benzodiazepines, opioids- NMPR	Prior 30-day use	Dichotomous	(1) non-PSU (2) cannabis and ecstasy (3) illicit only (4) ecstasy and cocaine (5) cannabis and medications (6) all substances

Parsons, J. T., Starks, T. J., Millar, B. M., Boonrai, K., & Marcotte, D. (2014). Patterns of substance use among HIV-positive adults over 50: implications for treatment and medication adherence. *Drug and Alcohol Dependence*, *139*, 33–40.	US, NYC phone survey with HIV positive adults 50 and older N=557	alcohol, marijuana, cocaine, opiates, poppers, other drugs (amphetamines, PCP, sedatives, solvents)	Prior 30-day use	Continuous	(1) exclusive alcohol use (2) alcohol and marijuana use (3) alcohol and cocaine/crack use (4) multiple substance use
Patra, J., Fischer, B., Maksimowska, S., & Rehm, J. (2009). Profiling poly-substance use typologies in a multi-site cohort of illicit opioid and other drug users in Canada-a latent class analysis. *Addiction Research & Theory*, *17*(2), 168–185.	Canada, multi-site cohort study of illicit opioid and other drug users known as OPICAN N=582	alcohol, cannabis, Demerol, Dialudid, heroin, methadone from street, morphine, Oxycontin, Percocet, Talwin/Ritalin, Tylenol 3 or 4, cocaine, crack, benzodiazepines, IDU	Prior 30-day use	Dichotomous	(1) Rx opioids and cocaine use injectors (2) Rx opioids non-injectors (3) cocaine and crack injectors (4) Rx opioid and crack non-injectors (5) nonuse (6) heroin and crack use injectors (7) intensive PSU injectors (8) alcohol use non-injectors
Quek, L.-H., Chan, G. C. K., White, A., Connor, J. P., Baker, P. J., Saunders, J. B., & Kelly, A. B. (2013). Concurrent and Simultaneous Polydrug Use: Latent Class Analysis of an Australian Nationally Representative Sample of Young Adults. *Frontiers in Public Health*, *1*, 61. doi: 10.3389/fpubh.2013.00061	Australia, 2007 National Drug Strategy Household Survey N=3,011	alcohol, tobacco, cannabis, ecstasy, methamphetamine, pain-killer, tranquilizers/sedatives, cocaine, hallucinogens	Prior year use	Dichotomous	(1) Alcohol only (2) Alcohol and tobacco (3) Cannabis, ecstasy, and licit drug use (4) Cannabis, amphetamine derivatives, and licit drug use (5) Sedative and alcohol use

Ramo, D. E., Grov, C., Delucchi, K., Kelly, B. C., & Parsons, J. T. (2010). Typology of club drug use among young adults recruited using time-space sampling. Drug and Alcohol Dependence, 107(2–3), 119. https://doi.org/10.1016/j.drugalcdep.2009.09.014	US, NYC Club Drugs and Health Project N=400	MDMA, cocaine, ketamine, GHB, methamphetamine, LSD	Prior 4-month use	Dichotomous	(1) primary cocaine (2) mainstream-MDMA mostly (3) wide range
Roth, A. M., Armenta, R. A., Wagner, K. D., Roesch, S. C., Bluthenthal, R. N., Cuevas-Mota, J., & Garfein, R. S. (2015). Patterns of Drug Use, Risky Behavior, and Health Status Among Persons Who Inject Drugs Living in San Diego, California: A Latent Class Analysis. *Substance Use & Misuse*, *50*(2), 205–214.	US, longitudinal study of IDU in San Diego known as STAHR-II study N=511	Heroin injection, methamphetamine injection, methamphetamine smoking, methamphetamine snorting, Rx drug swallowing, binge drinking, marijuana smoking	Prior 6-month use	Dichotomous	(1) multi modal methamphetamine (2) mostly heroin injection
Roy, É., Richer, I., Arruda, N., Vandermeerschen, J., & Bruneau, J. (2013). Patterns of cocaine and opioid co-use and polyroutes of administration among street-based cocaine users in Montréal, Canada. *International Journal of Drug Policy*, *24*(2), 142–149.	Canada, recruitment of regular users of cocaine through harm reduction services in Montreal N=886	IDU cocaine, smoked cocaine, snorted cocaine, IDU heroin, non IDU heroin, IDU NMPR and non IDU NMPR	Prior 30-day use	Dichotomous	(1) cocaine smokers (2) cocaine sniffer smokers (3) cocaine IDU (4) cocaine opioid injectors (5) cocaine opioid polyroute
Trenz, R.C., Scherer, M., Harrell, P., Zur, J., Sinha, A., & Latimer, W. (2012). Early onset of drug and polysubstance use as predictors of injection drug use among adult drug users. *Addictive Behaviors 37*(4), 367-372.	South Africa, NUERO-HIV study N=409	cigarettes, marijuana and heroin combo, marijuana and cigarettes combo, alcohol, crack	Prior 6-month use	Dichotomous	(1) MJ and cigarettes (2) MJ and heroin (3) crack (4) low use
Wu, L.-T., Woody, G. E., Yang, C., & Blazer, D. G. (2010). Subtypes of nonmedical opioid users: Results from the national epidemiologic	US, National Epidemiologic Survey on	marijuana, inhalants, cocaine, hallucinogens, heroin, sedatives,	Lifetime	Dichotomous	(1) opioid-marijuana (2) opioid-other Rx (3) opioid-pot-

survey on alcohol and related conditions. *Drug and Alcohol Dependence*, *112*(1), 69–80.	Alcohol and Related Conditions N=1,815	amphetamines, tranquilizers			hallucinogen (4) opioid-polydrug

Notes: IDU= injection drug use; NMPR= non-medical use of pain relievers; OST= opioid substitution therapies; PSU= polysubstance use; Rx= prescription

CHAPTER 2. HETEROGENOUS OPIOID USE AMONG JUSTICE-INVOLVED INDIVIDUALS: A LATENT PROFILE ANALYSIS OF POLYSUBSTANCE OPIOID USE (PAPER 1)

2.1 Introduction

Opioid use has reached epidemic levels, impacting individuals as well as criminal justice and healthcare systems nationwide. Opioid injection drug use (IDU) is increasingly problematic with overdose mortalities and public health risks such as the hepatitis C virus (HCV) and human immunodeficiency virus (HIV) increasing as a result (Van Handel et al., 2016). The majority of opioid related overdoses are due to polysubstance use, which includes the co-use of opioids with other drugs in a given timeframe (Ruhm, 2017).

Polysubstance use (PSU) refers to the patterns of diverse drug involvement when substances are used in the same time frame. PSU patterns can be simultaneous (i.e., substances taken at the same time), sequential (i.e., one substance followed by another), or in regular intervals (i.e., daily/weekly patterns of use). PSU is widespread, as nearly all individuals who use drugs do not restrict their substance use to one substance (Darke & Hall, 1995; Martinotti et al., 2009). Individuals who engage in PSU tend to be younger, with lower levels of education, and more extensive criminal histories (Darke & Hall, 1995; Martinotti et al., 2009). PSU is inherently risky, as it is shown to increase likelihood of both fatal and non-fatal overdose (Bretteville-Jensen, Lillehagen, Gjersing, & Andreas, 2015; Darke, 2014; Darke, Williamson, Ross, & Teesson, 2005; Jones et al., 2012) and HIV/HCV transmission risk through IDU practices (Harrell et al., 2012; Trenz et al., 2012; Wu et al., 2011).

2.1.1 PSU as Inherently Risky

The use of two or more substances greatly increases the risk of overdose. Among individuals who use opioids nearly one-third of fatal overdoses involve PSU (Mattson, 2018). In 2016, nearly 80% of synthetic-opioid deaths (e.g., fentanyl) involved another substance such as alcohol, another opioid, cocaine, or benzodiazepines (Jones, Einstein, & Compton, 2018). Post-

release from prison, individuals are at increased risk of overdose (Binswanger et al., 2007). A recent study found PSU prevalent in 56% of overdose deaths among formerly incarcerated individuals, with opioid and cocaine PSU as the most common pattern (Binswanger et al., 2013). Polysubstance opioid use is also associated with increased risk for non-fatal overdose (Betts et al., 2016; Roth et al., 2015).

Additional research has found an increased prevalence of IDU among PSU populations (Betts et al., 2015; Bretteville-Jensen et al., 2015). Further, distinct PSU patterns are significantly associated with increased HIV and HCV serostatus and risk factors. Individuals who co-use crack cocaine with nasal use of heroin were more likely to have HCV compared to individuals who only injected heroin (Harrell et al., 2012). Additionally, HIV/HCV risk behaviors such as syringe sharing may be more prevalent among PSU populations (Harrell et al., 2012; Meacham et al., 2015).

In addition to greater risk and symptomology, PSU complicates treatment. For example, in a sample of individuals entering treatment for heroin dependence, persistent cocaine use during treatment was associated with increased likelihood of return to heroin use (Williamson, Darke, Ross, & Teesson, 2006). Individuals with ongoing cocaine use during heroin treatment were also more likely to report criminal activity and imprisonment (Williamson et al., 2006). In a sample of methadone program patients, 61% reported increased or resumed misuse of benzodiazepines after entering treatment (Chen et al., 2011). This study also found that a majority of treatment patients were interested in treatment for benzodiazepine misuse, indicating that current treatment modalities may be overly focused on a primary substance of use and may miss important intervention opportunities.

2.1.2 Latent Modeling Techniques

Prior research has revealed that individuals who use opioids also use a variety of other substances (Betts et al., 2016; Patra, Fischer, Maksimowska, & Rehm, 2009; Wu, Woody, Yang,

& Blazer, 2010). Specifically, previous studies have identified opioid use in combination with alcohol, benzodiazepines, cocaine, marijuana, and amphetamines (Fong et al., 2015; Gjersing & Bretteville-Jensen, 2018; Kuramoto et al., 2011; Meacham et al., 2015; Wu, Woody, Yang, & Blazer, 2010). There are likely distinct preferences and reasons for each PSU pattern. For example, regular co-use of benzodiazepines and opioids is common with benzodiazepines involved in 51% of prescription opiate overdoses (Mattson, 2018). Regular interval use of benzodiazepines with opioids may be motivated by the reinforcing effects by which benzodiazepines amplify opioid intoxication (Chen et al., 2011; Jones et al., 2012).

Previous research of opioid use tends to focus on a sole substance of misuse/abuse/dependence despite evidence that the majority of individuals meet criteria for more than one substance use disorder (Anglin & Hser, 1991; Agrawal, Lynskey, Madden, Bucholz, & Heath, 2007). To consider the heterogeneity of PSU populations, researchers have advocated for the use of latent class analysis (Agrawal et al., 2007; Schwartz, Wetzler, Swanson, & Sung, 2010). Latent class analysis, a form of cluster analysis, is considered a person-centered approach in that it focuses on the relationships between heterogenous groups of individuals to group individuals into similar categories, known as classes (Collins & Lanza, 2010). Latent class analysis is preferable to previous deductive, variable-centered approaches as it allows for consideration of the diverse and multi-dimensional patterns of drug use (Collins & Lanza, 2010; Monga et al., 2007).

A number of studies have used latent class analysis to explore heterogeneity of substance use patterns among general populations, with less research focusing specifically on opioid PSU patterns (e.g., Fong et al., 2015; Gjersing & Bretteville-Jensen, 2018; Meacham et al., 2015; Wu et al., 2010). Previous research has utilized dichotomous latent class indicators, which more accurately capture regular interval PSU in the time-period analyzed. For example, Monga and colleagues (2007) explore substances individuals report using in the prior 30-days. A 30-day time

frame is commonly used in previous studies (e.g., Fong et al., 2015; Harrell et al., 2012; Patra, Fischer, Maksimowska, & Rehm, 2009). Other research utilizes ordinal categories of substance use (e.g., Betts et al., 2015; Carlson et al., 2014; Gjersing & Bretteville-Jensen, 2018). Only one known study used 30-day continuous indicators of substance use (Parsons et al., 2014), and the current research advocates further examination of PSU patterns using continuous indicators as necessary in order to provide more detailed insights to PSU patterns.

Among studies examining substance use patterns, none have examined patterns explicitly among a justice-involved sample. Some research examines justice-involvement as an independent variable, and has found more extensive PSU patterns associated with higher justice-involvement (Betts et al., 2016; Fernández-Calderón et al., 2015; Green, Black, Serrano, Budman, & Butler, 2011).

Compared to the general public, justice-involved populations have more severe drug use histories (Mumola & Karberg, 2006). Studies have found 30-74% of currently incarcerated individuals report using more than one substance prior to incarceration (Kubiak, 2004; Lo & Stephens, 2000) and one study found 10% of users met criteria for substance use disorder for two or more substances (Lo & Stephens, 2000). This indicates justice-involved populations have higher rates of PSU, and explicit examination of this population's PSU patterns are necessary in order to provide supportive treatment during incarceration as well as reentry and post-release treatment services.

2.1.3 Current Research

Justice-involved populations have complex histories which place them at a disproportionate risk for PSU. Criminal involvement is highest during periods of active use (Fisher et al., 2014), making justice system involvement a key intervention point. Individuals with PSU are more likely to be arrested or recidivate upon release (Fisher et al., 2014; Hakansson

et al., 2011). Given the current opioid epidemic, and that known estimates of PSU among justice-involved persons explore only prevalence and not patterns, the current research describes the PSU patterns of users of opioids prior to their entrance to a prison and jail-based substance abuse treatment program. Persons who use opioids are not a homogenous group and assuming that all individuals have similar substance-using patterns undermines the potential for successful treatment and reentry outcomes. In this study, a latent profile analysis (LPA) of justice-involved persons who report use of opioids with other substances is explored. LPA is a form of latent class analysis which uses continuous indicators instead of dichotomous or ordinal indicators. The current research expands previous research by providing the unique contributions of (1) examination of PSU patterns among a justice-involved population, and (2) use of continuous indicators and LPA to reveal detailed insights to PSU patterns.

2.2 Methods

2.2.1 Sample

Data from the current study were collected from the Criminal Justice Kentucky Treatment Outcome Study (CJKTOS). The study is on-going since 2005 with the collaboration of the Kentucky Department of Corrections (DOC) and the University of Kentucky Center on Drug and Alcohol Research (UK CDAR). Individuals entering KY DOC jails, prisons, and community corrections in need of substance abuse treatment are eligible to participate in a substance abuse program (SAP), which follows a therapeutic community model (De Leon, 2000). Baseline assessments were conducted by trained DOC staff using computer assisted personal interview (CAPI) software within the first two weeks individuals entered SAP. Consent to baseline assessment is part of DOC consent to treatment. A federal certificate of confidentiality was obtained.

The current analyses are limited to the three most recent cohorts: 2015, 2016, and 2017 (n=17,203). Further, the sample was limited to include only individuals in prison or jail-based SAP (n=13,490). Finally, individuals in current analysis must have reported use of an opioid (e.g., heroin, illicit suboxone, non-prescribed opiates) in the 12-months (n=7,837) prior to incarceration and had to have reported using more than one substance on a given day in the month prior to incarceration, resulting in a final sample size of 6,569. Individuals were incarcerated an average of 1.70 years before entering SAP and receiving their baseline assessment.

2.2.2 Variables

2.2.2.1 Latent Profile Indicators

The baseline assessment contained a variety of demographic, criminal history, mental and physical health, and substance use questions. Individuals were first asked if they used a substance in the 12-months prior to their incarceration. If an individual indicated they used a substance, they were then asked about use of the substance in the 30-days prior to incarceration (i.e., number of days used). Following previous studies and statistical practices (Kuramoto et al., 2011; Monga, et al., 2007), only 30-day drug use that was engaged by a minimum of 20% of the sample was included in the current research. This resulted in the exclusion of barbiturates (5.7%), hallucinogens (7.2%), inhalants (2.9%), non-prescribed methadone (14.8%), and synthetic drugs (16.8%). Latent profiles were created based on previous 30-day use of alcohol, cocaine, marijuana, heroin, non-prescribed suboxone, non-prescribed opiates, amphetamines, and tranquilizers.

2.2.2.2 Sociodemographic

Age and years of education were measured as continuous variables. Gender (1=male) and race (1=white) were dichotomously measured. The county an individual lived in prior to

incarceration was coded utilizing a rural-urban coding scheme (Ingram & Franco, 2014) such that codes 1-3 were coded as 0=urban and 4-6 were 1=rural. Employment (1=unemployed) in the 30-days prior to incarceration was measured dichotomously. Additionally, prior 12-month homelessness was also measured (1=homeless during prior 12-months). Pre-incarceration financial strain was measured on an 8-item summative scale (α=.87; R:0-8) of economic hardship adapted from the Survey of Income and Program Participation to include difficulty meeting needs of food, housing, clothing, and medical care (Beverly, 2001).

2.2.2.3 Physical Health

Individual's physical health was measured by three variables. A dichotomous variable measured if individuals reported chronic pain where pain persisting or recurring three months or longer was coded "1" and no pain or pain not meeting that criteria was coded "0". Additionally, HCV status was measured by a question asking if the individual had been told by a doctor that they have the hepatitis C virus. A continuous variable measuring the number of poor physical health days in the 30-days prior to incarceration was also included via the question, "Thinking about your physical health, which includes physical illness and injury, during the 30 days prior to this incarceration, how many days was your physical health not good?" (R:0-30).

2.2.2.4 Mental Health

Anxiety and depressive symptoms in the 12-months prior to incarceration were measured using a modified dichotomous version of the Generalized Anxiety Disorder-7 (GAD-7; Spitzer, Kroenke, Williams, & Löwe, 2006) (α= .97; R:0-7) and the Patient Health Questionnaire-9 (PHQ-9; Spitzer, Kroenke, Williams, & Group, 1999) (α=.94; R: 0-9). Additionally, three questions measuring stress-related health consequences were examined (Logan & Walker, 2010). These questions ask if participants (1) used illegal drugs to reduce stress, anxiety, worry or fear; (2) used alcohol to reduce stress, anxiety, worry or fear; and (3) used prescription drugs to reduce

stress, anxiety, worry or fear in the week prior to their incarceration. Answers were collapsed so that individuals reporting response of 'most of' or 'all of the time' were compared to those reporting 'none of' or 'some of the time.' A continuous variable measuring the number of poor mental health days in the 30-days prior to incarceration was also included via the question, "Thinking about your mental health, which includes stress, depression and problems with emotions, during the 30 days prior to this incarceration, how many days was your mental health not good?" (R: 0-30).

2.2.2.5 Criminal History

A continuous variable measuring self-reported lifetime number of criminal convictions was included. In addition, a series of dichotomous variables were created to measure prior 12-month arrests according to offense type (drug, violent, property). Drug crimes included trafficking, possession, paraphernalia, and manufacturing charges. Violent crimes included weapon offenses, robbery, assault, rape, and homicide. Property crimes included shoplifting, burglary, and arson. There were other crimes that did not fit one of the three categories (e.g., receiving stolen property, 5.6%), which were excluded. Individuals could report prior arrests for more than one type of crime.

2.2.3 Analysis

LPA was utilized to determine the unobserved patterns of the data utilizing the 30-day reported substance use indicators to form subgroups. A simple model (1-class) was fit first and classes were then incrementally increased until selection criteria began to decline. Selection criteria were based on standard fit statistics of Akaike Information Criteria (AIC), Bayesian Information Criteria (BIC), and likelihood ratio tests. Although AIC and BIC were slightly improved with a 7-profile solution, the profiles were not parsimonious and did not reach

separation. A six-profile model was the most parsimonious, homogenous, with separation (see Table 2.1).

Once the final six-profile model was selected, cross-validation and model convergence was tested by randomly varying the starting points for the maximum likelihood. A model is considered identified when classes consistently converge regardless as to maximum likelihood starting point (Collins & Lanza, 2010). Random iterations and the log likelihood converged to the same six-factor model selected in 76.2% of tests indicating the six-profile solution was well-fitting and robust.

Individuals were assigned to profiles based on their most likely profile membership. Profile membership is independent in that individuals cannot belong to more than one profile. Chi-square tests and ANOVA were used to determine if profiles differed from each other on associated variables. Multinomial logistic regressions were used to predict profile membership (i.e., latent profile as outcome variable), adjusted for relevant variables. All analyses were conducted using the latent class functions in Stata version 15.1.

2.3 Results

2.3.1 Profile Membership

The six-profile model selected appears in Table 2.2, with mean number of days of substance use in the 30-days prior to incarceration. Profile 1 (P1) representing 9.4% of the sample was characterized by near daily alcohol use with substantial co-use of marijuana and opiates about 50% of the month (Primarily Alcohol P1). Profile 2 (P2) was characterized by near-daily use of heroin and co-use of marijuana and opiates about 40% of the month (Primarily Heroin P2). The most prevalent profile, with 34.3% of the sample, was characterized by Low PSU (P3). While use of opiates and marijuana was still substantial, compared to other profiles the Low PSU P3 did not have any drug use above 20 days per month. Profile 4 (P4), with 16.3% of the sample,

was characterized by high PSU, particularly of opiates and near daily use of tranquilizers. Co-use of marijuana and amphetamines was additionally high (High PSU P4), occurring 30-40% of the days of the month. Profile 5 (P5) was the smallest group with 7.8% of the sample. Individuals in this profile had daily use of illicit suboxone with substantial co-use of marijuana, opiates, and amphetamines about 40% of the month (Primarily Suboxone P5). Profile 6 (P6) was characterized by near daily cocaine use and high co-use of marijuana, opiates, and heroin 50-60% of the month (Stimulant-Opioid P6).

2.3.2 Characteristics of Sample

Sociodemographic, physical health, mental health, and criminal history information of the total sample and by latent profile is provided in Table 2.3. The overall study population was predominantly white males in their 30s with an average of 12 years of education/GED. The sample was equally split between rural and urban, with the majority (54%) employed prior to incarceration. Approximately one-third had experienced homelessness in the 12 months prior to incarceration and reported an average of two sources of financial strain. Twenty-one percent of the sample reported having HCV, and nearly 30% reported chronic pain. Individuals reported an average of 7 days of poor physical health and nearly 12 days of poor mental health in the past 30 days. Anxiety and depression scores were mid-range for each scale. The majority of individuals reported using illegal drugs to cope, less reported use of prescriptions, and even fewer individuals reported using alcohol to cope. The average person was incarcerated 1.7 years with a history of 10 previous convictions. Drug crimes were the most prevalent offense followed by property crimes in the 12 months before incarceration.

2.3.3 Sociodemographic Characteristics of Profiles

All variables were significantly different by latent profile as indicated by chi-square and ANOVA tests. Post-hoc Tukey-Kramer comparisons were performed after ANOVA results

($p<.05$), and relevant results are discussed. Individuals characterized by Primarily Alcohol P1 were significantly older ($\bar{x}$ =34.22) than all profiles except High PSU P4. Primarily Heroin P2 were on average the youngest ($\bar{x}$ =31.58), and significantly younger than all profiles other than Stimulant-Opioid P6. Primarily Suboxone P5 individuals had significantly lower level of education compared to Primarily Heroin P2, Low PSU P3, and High PSU P4. While all profiles consisted of mostly males, individuals in Primarily Alcohol P1 had the highest prevalence (88.7%). The Primarily Suboxone P5 group averaged the highest majority white (68.4%) compared to the lowest prevalence of Primarily Alcohol P1 (57.3%). Only 27.9% of Primarily Heroin P2 lived in rural locations prior to incarceration, contrasted with 75.8% of Primarily Suboxone P5. Individuals included in Primarily Alcohol P1 were most likely to have employment before incarceration. Homelessness and economic hardship were more common among Primarily Heroin P2 and Stimulant-Opioid P6 than all other profiles.

2.3.4 Physical and Mental Health Characteristics of Profiles

Primarily Alcohol P1 individuals had the lowest reported HCV prevalence while highest reported HCV was 26.7% among the Primarily Heroin P2 individuals. Chronic pain was highest among Primarily Suboxone P5. The Low PSU P3 group reported significantly lower physical and mental health symptomology (days and depression/anxiety) compared with the Primarily Heroin P2, High PSU P4, and Stimulant-Opioid P6. Other significant differences were found across mental and physical health variables when comparing the High PSU P4 group to the Primarily Suboxone P5.

Primarily Suboxone P5 individuals also had on average higher reports of using prescriptions and illegal drugs to cope. Reports of using illegal drugs to cope were also high (80.1%) among Primarily Heroin P2. Unlike the total sample and other profiles, Primarily Alcohol P1 was most likely to report using alcohol to cope.

2.3.5 Criminal History Characteristics of Profiles

Individuals characterized by Primarily Alcohol P1 patterns were incarcerated a longer number of years compared to Primarily Heroin P2, Low PSU P3, and Primarily Suboxone P5. This group also had higher than average lifetime convictions and violent crimes. The Stimulant-Opioid P6 group had the highest average number of convictions, with significant differences observed between this group and Primarily Heroin P2, Low PSU P3, and High PSU P4. The Stimulant-Opioid P6 profile had the highest average number of arrests for property crimes. Individuals characterized by Largely Heroin P2 had the lowest amount of reported violent crime arrests. The Low PSU P3 reported the highest amount of arrests for drug-related crimes.

2.3.6 Multivariate Models

Table 2.4 contains multinomial logistic regression identifying the correlates associated with profile membership using variables which were associated with latent profiles at the $p<.05$ level (correlation matrix not shown). The Low PSU P3 group was chosen as the comparison group so that it could be understood how the higher risk profiles differed (i.e., which characteristics may be associated with riskier PSU patterns). Compared to Low PSU P3, individuals were more likely to be classified as Primarily Alcohol P1 if they reported using alcohol to cope and with increasing number of convictions. Those who reported using prescription or illegal drugs to cope were less likely to be classified as Primarily Alcohol P1.

Individuals were more likely to be classified as Primarily Heroin P2 if they had lived in urban areas, used illegal drugs to cope, and had a history of IDU. If individuals had lived in a rural area and with increasing poor physical health and anxiety symptoms, they were more likely to be in the High PSU P4 group. Additionally, individuals were more likely to be High PSU P4 if

they had lower levels of education, reported alcohol and prescription use to cope, injected drugs, and had a greater number of lifetime convictions.

Individuals with lower levels of education or who lived in rural areas were more likely to be in the Primarily Suboxone P5 group. With increased anxiety symptoms and histories of using prescriptions to cope, individuals were more likely to be classified as Primarily Suboxone P5 as well. Individuals were less likely to be in this profile with decreased depression symptomology or if they used alcohol to cope. Individuals who were HCV positive were most likely to be classified as Stimulant-Opioid P6. Individuals were also likely to be classified in Stimulant-Opioid P6 with lower levels of education, urban living, increasing depression symptoms and a history of using alcohol to cope. Further histories of IDU, property crimes, and a greater number of convictions was associated with increased likelihood of being classified by Stimulant-Opioid P6 profile.

2.4 Discussion

The current research is among the first to explore PSU among a sample of justice-involved persons who use opioids. Specifically, LPA identified six distinct profiles of opioid PSU in the 30-days prior to incarceration with profiles distinguished by their use of Primarily Alcohol, Primarily Heroin, Low PSU, High PSU, Primarily Suboxone and Stimulant-Opioid. These profiles differed in key ways which are relevant to public health and criminal justice systems and can be used to inform intervention development. Qualitative summaries of differences are described in Table 2.5.

All profiles in the current research reported co-use of marijuana at least 40% of the month. The high co-use of marijuana and opioids has been observed among PSU populations (Monga et al., 2010; Trenz et al., 2012; Wu et al., 2010). In a study of users of opioids in Canada, marijuana use was 50% or greater among latent classes (Monga et al., 2007). Previous research demonstrates the role of the endocannabinoid system in opioid use disorder, and the potential for

marijuana to diminish opioid withdrawal (Bisaga et al., 2015). Considering all profiles reported substantial use of opioids by study design, it is possible that high marijuana use is related to a pharmacological desire or need to reduce symptoms of opioid withdrawal.

Individuals classified as Primarily Alcohol P1 were older, reported using alcohol to cope, with more extensive incarceration histories including a history of violent crimes. Generally, a curvilinear age to crime relationship exists, such that older individuals become less criminally involved (Sampson & Laub, 1995). While older, individuals in this profile were only an average of 34 years old; this remains an age range for which extensive offending occurs, particularly for alcohol and drug related offenses (Sampson & Laub, 2003). Additionally, alcohol use is a common correlate of violent crimes (Graham & Livingston, 2011). Given the propensity for individuals in this profile to report drinking alcohol as a method of coping, appropriate interventions which introduce effective coping mechanisms are appropriate. It has long been noted that relapse to alcohol use is likely during stressful experiences among individuals with limited coping skills (Rohsenow et al., 2001). Providing coping skill training reduces future alcohol relapse, both when provided alone (Rohsenow et al., 2001) and in conjunction with pharmacotherapies (O'Malley et al., 1992). While therapeutic communities, a common prison-based substance program, often require desistance from unhealthy coping mechanisms, there is no known longitudinal research on the use of these coping skills post-release including the effects of training on post-release substance use. However, research indicates individuals who enroll in therapeutic community aftercare are most likely to remain substance-free long-term (Inciardi, Martin, & Butzin, 2004), supporting the idea that assistance with coping skills in presence of relapse stimuli (e.g., alcohol) would be most effective (Rohsenow et al., 2001).

Those classified as Primarily Heroin P2 were younger, more likely to be HCV positive, lived in urban areas, reported IDU, and the use of illegal drugs to cope. Considering the findings on coping, the previous recommendations regarding coping skills would apply for this population

as well. The young age, HCV probability, and IDU practices of this population when combined with consideration that substance use is a chronic relapsing disorder, indicates that harm reduction resources and pharmacotherapies should be made readily available. Opioid substitution therapies (OST) remain a safe and cost-effective method to treat individuals with an opioid use disorder (Volkow, Frieden, Hyde, & Cha, 2014), but are underutilized in justice settings (Friedmann et al., 2012). Owing to a focus on 'drug-free' as a 'true recovery' among treatment centers (Friedmann & Suzuki, 2017), it is highly unlikely that discussion of harm reduction resources occurs. It is critical that individuals such as those identified in the Primarily Heroin P2 profile are provided with safe reentry resources and appropriate medications for treatment in addition to psychosocial services.

Individuals in the Low PSU P3 were characterized by markedly lower PSU, but still reported frequent use (i.e., 30% or more of month) of marijuana, opiates, and amphetamines. Thus while their PSU patterns were 'low' when compared to the more severe patterns of their justice-involved peers, they are still quite high compared to more general populations (e.g., Parsons et al., 2014). Individuals classified by this PSU pattern had higher than average education and the lowest prevalence of IDU. While they are not as high-risk as other individuals, their risk remains substantial. As no outstanding characteristics arose from this group, it is possible that standard correctional treatment modalities would assist in reducing their substance use. Due to the elevated use of opiates, individuals in this profile would benefit from screening for opioid use disorder and potential OST, when applicable.

The High PSU P4 profile represents a high-risk group in need of substantial intervention. While previous latent class analyses have found a PSU class with comparably higher PSU patterns from other classes (Fong et al., 2015; Harrell et al., 2012; Kelly et al., 2014; Kuramoto et al., 2011; Morley et al., 2015; Parsons et al., 2014; Patra et al., 2009; Wu et al., 2010), similar to those observed in the current High PSU profile, the type of substances used vary based on study

inclusion. Instead it remains notable that among most samples of substance users, a proportion engage in more heterogenous patterns of frequent use. Additionally, since previous research utilized dichotomous and ordinal measures of substance use, it is difficult to make comparisons with regards to the patterns of PSU observed in the current sample. Despite these differences, research has found that those latent classes with more diverse drug involvement are at risk for poor outcomes (Connor et al., 2013; Quek et al., 2013; Wu et al., 2011).

This profile's association with chronic pain, poor physical and mental health, and reported illicit prescription drug use to cope should be considered. Further, assessment and treatment of physical and mental health are imperative. Appropriate intervention for coping skills should be implemented. With caution, as causality of variables cannot be accounted, this profile appears to exhibit characteristics indicative of a self-medication model of substance use. It is important to note that individuals need not meet criteria of a disorder (e.g., depression) for self-medication to occur (Mariani, Khantzian, & Levin, 2014). Rather, the perceived pain and psychological distress lead an individual to focus on the relief and control of pain (physical and psychological) (Khantzian, 2003). Further, the patterns of an individual's self-medication are crucial in understanding which appropriate psychological and psychopharmacological treatment approaches are most appropriate (Khantzian, 2003; Mariani et al., 2014).

A study by Betts and colleagues (2015) found that individuals with certain PSU patterns were at increased risk of overdose only when psychological distress was also found. That is, something about the nature or way that distressed individuals consume multiple substances places them at increased risk for nonfatal overdose (Betts et al., 2015). Since co-consumption of tranquilizers (e.g., benzodiazepines) with opioids already places individuals at greater risk of overdose, the individuals in the High PSU P4 are at extreme risk of negative outcomes without appropriate targeted interventions.

Individuals in the Primarily Suboxone P5 group represent a unique profile, which has not previously been found in the literature. Individuals in this profile reported near daily use of illicit suboxone, with co-use of marijuana, opiates, and amphetamines. These individuals were more likely to have lived in rural locations with reported lower levels of education. The rurality of this profile is important to consider. Rural areas of Kentucky have limited methadone and other treatment access (Bunting et al., 2018). Some evidence suggests that overprescribing or 'doctor shopping' contributes to the diversion of Suboxone (Furst, 2014). These are the same mechanisms mentioned in rural areas when examining diversion of prescription opiates (Leukefeld, Walker, Havens, Leedham, & Tolbert, 2007), indicating the unique importance of rurality for this finding and the potential that indiscriminate Suboxone prescribing may be filling a void left by the crackdown on pain clinics. Again, motivations for use are unknown among this sample, but it is posited that these individuals represent a new form of the self-medication hypothesis, specific to the opioid epidemic. Research has explored motivations for illicit buprenorphine use (Yokell, Zaller, Green, & Rich, 2011) and while some studies report diverted use for euphoric effects, substantial evidence exists to support that illicit use can be motivated by therapeutic purposes (i.e., self-treatment of opioid withdrawal symptoms) (Bazazi, Yokell, Fu, Rich, & Zaller, 2011; Hakansson, Medvedeo, Andersson, & Berglund, 2007; Schuman-Olivier et al., 2010). However, this should not assume that illicit use is without consequences. Although the use of illicit Suboxone may be safer than heroin use, due to the unknown purity and adulterants in heroin, its use remains a risk for overdose particularly when PSU or IDU is involved (Bretteville-Jensen et al., 2015; Yokell et al., 2011). This profile provides a crucial intervention point for access to prescribed Suboxone and the addition of psychosocial counseling under the care of a licensed-buprenorphine healthcare provider during the captive moment of incarceration.

Lastly, individuals in the Stimulant-Opioid P6 were found to have lower education, a greater number of depressive symptoms, more likely to be HCV positive, and a more pronounced

history of property crimes. This profile has been found in other research of PSU patterns (Harrell et al., 2012; Kuramoto et al., 2011; Meacham et al., 2015; Monga et al., 2007; Patra et al., 2009; Roy, Richer, Arruda, Vandermeerschen, & Bruneau, 2013). The use of stimulants with opioids is a more common PSU pattern, owing to more pleasurable effects or the use of stimulants to reduce opioid withdrawal symptoms (Leri et al., 2003). This repeated finding demonstrates that at the time of assessment, treatment providers have the potential to classify individuals PSU patterns. While future research is needed to determine if the current findings replicate in other justice settings, at this point substantial evidence exists that PSU of stimulants and opioids occurs. Consideration of separate and unique treatment for this population could be warranted. As research finds distinct motivations for stimulant-opioid co-use (e.g., euphoric effects, stave withdrawal), further understanding of the motivation of co-use among this population would be beneficial. For example, individuals who co-use stimulants to postpone withdrawal might benefit from OST.

The current research was descriptive in nature, but the intended goal is to provide critical information for criminal justice and public health officials. While PSU is risky and poor outcomes are increased among general populations, the risks for justice-involved populations are unique. Justice-involved persons leave prisons and jails after periods of prolonged substance abstinence. The risk of overdose is 129 times greater upon reentry (Binswanger et al., 2007). Tailoring intervention efforts during incarceration has the potential to reduce risky PSU patterns post-release, reduce future criminal justice involvement, and save lives. Recognizing that opioid use, and substance use in general, is heterogenous and diverse is crucial to successful treatment and intervention success.

2.4.1 Recommendations for Future Research

This research was among the first to utilize LPA with 30-day indicators of substance use as opposed to dichotomous and ordinal substance use variables in latent class analysis. The only

other known study to explore PSU using continuous latent variable is Parsons and colleagues (2014), which was a limited sample of HIV positive adults over the age of 50 in New York City. While several studies have examined PSU patterns of opioids (Fong et al., 2015; Gjersing & Bretteville-Jensen, 2018; Kuramoto et al., 2011; Meacham et al., 2015; Wu et al., 2010), there is a need for future research to utilize continuous indicators and LPA so that more nuanced understandings of PSU may occur. Further, future research should include indicators that this current study did not measure- such as method of use (i.e., injection, snort, smoke, swallow) and inclusion of commonly known simultaneous PSU substances (e.g., speedball). Improved polysubstance use measures that capture simultaneous and sequential use, as well as studies that explore motivations for PSU are needed.

Whenever available, associated variables measured the 30-days prior to incarceration so as to be consistent with the 30-day LPA indicators. However, this was not always possible, due to measurement design and leaves uncertain the causality of results. Further, the current research examined only the phenomena of purposeful PSU- that is unknown PSU was not considered. Unintentional or unknown PSU is increasing due to synthetic opioid analogs adulterating other substances (Krieger et al., 2018). While the risks of unintentional PSU are great, the goal of the current research was to understand purposeful PSU in order to examine risk taking behaviors that are employed with active agency. Given the prominence of synthetic opioids, it is likely that individuals in the current sample- particularly those consuming heroin- unintentionally ingested other substances as well. Future research of PSU should consider the juxtaposition of intentional versus unintentional PSU behaviors. Finally, all behaviors were self-reported in a criminal justice setting. While extensive research has indicated that self-report measures of substance use are likely legitimate (Darke, 1998), there is the possibility of inaccurate details due to lack of rapport, bias, or recall.

The current study was the first known study to explore PSU in a justice-involved sample and while several previous studies likely have samples consisting of those with justice-involvement, the current research explicitly considered this as integral to the research. Future studies should examine PSU among justice-involved populations, particularly at the point of introduction to the justice system since substance use is likely elevated at this time point. Future studies of PSU should also consider measuring previous justice involvement, and this variable as a possible stratification of groups for future latent class/profile analyses, as well as post-release patterns in latent transition analysis.

2.4.2 Conclusions

The current research is the first to examine the polysubstance profiles of justice-involved users of opioids. There were distinct profiles of opioid use, highlighting the diverse substance involvement of justice-involved populations. The current sample differed in these patterns of use by sociodemographic, physical health, mental health, and criminal history. Justice involvement provides a crucial point for intervention and criminal justice agencies should consider treatment efforts focused on unique patterns of substance use. Future research of the diverse substance patterns of justice-involved individuals, to include longitudinal research, is crucial to curbing the opioid epidemic.

Table 2.1 Fit statistics for a latent profile analysis of polysubstance opioid use

Number of Profiles	Log-likelihood	Degrees of freedom	Akaike Information Criteria	Bayesian Information Criteria
1	-204822.7	16	409677.5	409786.1
2	-201122.9	25	402295.7	402465.5
3	-200226.8	34	400521.7	400752.6
4	-199959.5	43	400005.1	400297.1
5	-197275.0	52	394654.1	395007.2
6	-196888.3	61	393898.7	394312.9
7	-196519.7	70	393179.4	393654.7

Note: Latent profile selected shown in bold.

Table 2.2 Latent profile conditional means for polysubstance opioid use

	Profile 1 (N= 618)	Profile 2 (N=1,247)	Profile 3 (N=2,255)	Profile 4 (N=1,070)	Profile 5 (N=513)	Profile 6 (N=866)
Descriptive profile abbreviation	Primarily Alcohol P1	Primarily Heroin P2	Low PSU P3	High PSU P4	Primarily Suboxone P5	Stimulant -Opioid P6
Latent Profile indicators: Prior 30- day use						
Alcohol	28.03	3.94	2.43	7.51	1.96	10.22
Cocaine	1.28	1.73	0.73	1.20	0.82	27.38
Marijuana	14.65	11.53	12.11	16.47	12.18	17.99
Heroin	1.20	28.88	1.37	7.47	1.30	14.93
Suboxone	4.93	4.56	1.63	9.46	29.03	8.60
Opiates	14.30	12.94	14.21	20.80	12.28	18.18
Amphetamines	9.38	9.18	10.77	12.04	12.73	11.18
Tranquilizers	2.78	2.52	1.78	28.66	2.29	11.01
Profile Prevalence	9.41%	18.98%	34.33%	16.29%	7.81%	13.18%

Table 2.3 Characteristics of poly-opioid use in a criminal justice sample (N=6,569)

	Total Sample	Primarily Alcohol P1	Primarily Heroin P2	Low PSU P3	High PSU P4	Primarily Suboxone P5	Stimulant-Opioid P6
Sociodemographic							
Age	32.72 (8.07)	34.22 (8.88)	31.58 (7.17)	32.87 (8.24)	33.28 (8.47)	32.12 (7.27)	32.52 (7.89)
Education Level	11.91 (2.13)	11.88 (2.10)	12.02 (1.98)	12.02 (2.10)	11.77 (2.30)	11.63 (2.13)	11.80 (2.20)
Male	81.88	88.67	80.27	81.24	79.44	83.63	83.03
White	60.71	57.28	64.96	59.02	58.41	68.42	59.70
Rural	50.18	54.05	27.99	52.90	62.06	75.83	42.38
Unemployed	45.71	38.67	46.75	45.28	48.41	46.78	46.42
Homeless	28.01	27.67	36.09	23.55	23.55	23.0	36.72
Economic Hardship (R:0-8)	1.93 (2.48)	1.88 (2.45)	2.30 (2.69)	1.69 (2.29)	1.82 (2.37)	1.83 (2.39)	2.27 (2.71)
Physical Health							
HCV positive	20.99	13.43	26.78	17.34	21.12	24.37	25.40
Chronic Pain	29.12	28.48	26.30	29.50	36.07	25.15	27.60
Number of poor physical health days in past month	7.23 (11.92)	6.14 (11.40)	7.73 (12.23)	6.37 (11.29)	9.05 (12.83)	6.26 (11.16)	7.85 (12.35)
Mental Health							
Anxiety (R:0-7)	3.48 (3.21)	3.52 (3.23)	3.48 (3.21)	3.13 (3.17)	3.96 (3.19)	3.34 (3.23)	3.90 (3.18)
Depression (R:0-9)	4.30 (3.62)	4.29 (3.65)	4.46 (3.63)	3.83 (3.60)	4.84 (3.59)	3.76 (3.60)	5.00 (3.46)
Number of poor mental health days in past month	11.74 (13.70)	11.91 (13.89)	11.99 (13.89)	10.53 (13.23)	13.95 (13.99)	10.24 (13.19)	12.59 (14.00)
Use alcohol to cope	27.46	66.99	19.09	17.87	31.78	15.20	38.22
Use Rx drugs to cope	50.66	48.87	42.82	43.41	72.99	54.97	51.96
Use illegal drugs to cope	71.75	64.40	80.11	63.73	80.56	66.08	78.29
Criminal History							
# of years incarcerated	1.70 (2.29)	2.02 (2.68)	1.45 (2.17)	1.68 (2.04)	1.87 (2.79)	1.44 (1.40)	1.81 (2.48)
Lifetime number of convictions	10.10 (14.29)	11.48 (16.23)	10.07 (12.63)	8.69 (12.55)	11.07 (15.99)	9.20 (14.23)	12.19 (16.67)

Table 2.3 (continued)

	Total Sample	Primarily Alcohol P1	Primarily Heroin P2	Low PSU P3	High PSU P4	Primarily Suboxone P5	Stimulant-Opioid P6
Arrest for property crimes past 12-months	18.44	17.31	20.45	16.19	17.01	18.52	23.90
Arrest for violent crimes past 12-months	9.79	12.62	6.50	10.07	10.84	7.02	12.12
Arrest for drug crimes past 12-months	29.02	23.14	28.71	31.71	28.97	26.71	28.06

Notes: Percentages and means (SD) presented. All variables significant at $p<.001$ level with exception of unemployment which is significant at the level of $p<.01$

Table 2.4 Estimated significant relative risk ratios and 95% confidence intervals between relevant variables and poly-opioid use in a criminal justice sample compared to Low PSU(P3)

	Primarily Alcohol P1	Primarily Heroin P2	High PSU P4	Primarily Suboxone P5	Stimulant -Opioid P6
Education level			0.94** (0.91-0.98)	0.93*** (0.88-0.97)	0.94** (0.91-0.98)
Rural		0.31*** (0.27-0.37)	1.29*** (1.11-1.51)	2.50*** (2.00-3.13)	0.63*** (0.54-0.75)
Unemployed					
HCV positive					1.27* (1.03-1.56)
Number of poor physical health days in past month			1.01* (1.00-1.01)		
Anxiety			1.03* (1.00-1.06)	1.04* (1.00-1.08)	
Depression				0.96* (0.93-0.99)	1.05** (1.02-1.08)
Use alcohol to cope	14.91*** (11.70-18.99)		1.44*** (1.20-1.73)	0.72* (0.55-0.96)	2.50*** (2.07-3.03)
Use Rx drugs to cope	0.70** (0.56-0.88)	0.74*** (0.63-0.88)	2.73*** (2.27-3.29)	1.66*** (1.31-2.10)	
Use illegal drugs to cope	0.42*** (0.33-0.54)	2.15*** (1.77-2.60)			1.38** (1.12-1.71)
Injection drug use		4.11*** (3.42-4.96)	1.32*** (1.12-1.56)	1.85*** (1.47-2.33)	1.42*** (1.19-1.71)
Property crimes					1.48*** (1.22-1.81)
Lifetime number of convictions	1.01*** (1.01-1.02)		1.01*** (1.00-1.02)		1.01*** (1.01-1.02)

Note: Significance indicated by *p<.05, **p<.01, ***p<.001

Table 2.5 Comparison summary of latent profiles

Profile	Profile Description	Uniqueness of profile
1	Primarily Alcohol	Older Use alcohol to cope More multiracial Incarcerated longest
2	Primarily Heroin	Youngest HCV + Urban IDU Use illegal drugs to cope
3	Low PSU	Higher education Lowest IDU prevalence
4	High PSU	Chronic pain Poor physical and mental health Use Rx drugs to cope
5	Primarily Suboxone	Rural Less education White
6	Stimulant-Opioid	Less education Urban HCV+ Greater # of depressive symptoms Property crimes

CHAPTER 3. RETURN TO SUBSTANCE USE: A POST-RELEASE EXAMINATION OF POLYSUBSTANCE USE (PAPER 2)

3.1 Introduction

Substance use histories are endemic to the criminal justice system. Over 50% of individuals in state prisons and jails meet the criteria for substance dependence or abuse compared with only 5% of general populations (Bronson, Stroop, Zimmer, & Berzofsky, 2017; James & Glaze, 2006). This becomes more pressing in the current era of opioid use and the overdose epidemic. Individuals with justice involvement have long faced an increased risk of overdose and death following release from prison or jail (Binswanger 2007) owing to relapse after prolonged periods of substance abstinence. The most recent leading cause of death among formerly justice-involved individuals in Washington State was overdose from opioids, compared to overdose from cocaine in the early 2000s (Binswanger, Blatchford, Mueller, & Stern, 2013). Further, over 50% of all overdose deaths among formerly justice-involved persons were found to be due to polysubstance opioid use (Binswanger et al., 2013).

Polysubstance use (PSU) refers to the unique patterns of use that includes more than one drug. PSU can be simultaneous (e.g., two or more substances at the same time), sequential (i.e., one substance followed by another), or regular interval (i.e., two or more substances used in the same day/week/month). PSU involving opioids with a substance from another class is increasingly common and is a substantial contributor to overdose deaths (Jones, Einstein, & Compton, 2018; Ruhm, 2017).

Risk for overdose among justice-involved persons is highest in the first weeks after release (Binswanger et al., 2013). Compounded with unique challenges to reentry such as barriers to housing, employment, and health care, individuals returning to the community are significantly burdened. It is crucial to understand the factors that are associated with post-release relapse among justice-involved populations, amid consideration of high prevalence of PSU opioid use in

this population. As such, the current study examines pre-incarceration PSU opioid patterns and other identified risk factors as predictors of post-release relapse.

3.1.1 Conceptual Framework

Conceptual consideration of risk factors for post-release relapse in the current study were guided by the Behavioral Model for Vulnerable Populations (Gelberg, Andersen, & Leake, 2000). The model posits that predisposing, enabling, and need factors typified by their relation to traditional (i.e., general) and vulnerable populations, influence utilization of health services and health status (see Figure 3.1). Predisposing factors exist before health needs, such as demographic characteristics. Enabling factors affect the ability of an individual to secure necessary resources or care, such as personal and economic resources. Need factors include health problems and perceived health concerns. These factors are divided by traditional and vulnerable domains according to their relation to general and vulnerable populations.

Previously, this model has been utilized to examine homeless populations (Kushel, Perry, Bangsberg, Clark, & Moss, 2002; Stein, 2007), formerly incarcerated (Goshin & Byrne, 2012; Oser, Bunting, Pullen, & Stevens-Watkins, 2016), and substance-using populations (Victor, Kheibari, Staton, & Oser, 2018). Outcomes previously examined include emergency room use (Kushel et al., 2002; Oser et al., 2016), substance use treatment (Victor et al., 2018), and post-release relapse (Krishnan et al., 2013). The one known study to explore post-release relapse examined relapse to cocaine and opioid use among a cohort of HIV-positive individuals six-months post-incarceration (Krishnan et al., 2013). Predisposing factors of homelessness and marital status as well as need factors such as alcohol and drug use severity were significant predictors of post-release cocaine and/or opioid use (Krishnan et al., 2013). However, this study did not categorize factors by traditional or vulnerable domains.

Increased risk of relapse is associated with traditional domain variables of younger age (Kopak, Hoffmann, & Proctor, 2016) and unemployment (Evans, Hahn, Lum, Stein, & Page, 2009; Kadam, Sinha, Nimkar, Matcheswalla, & De Sousa, 2017; Steensma, Boivin, Blais, & Roy, 2005). Co-morbid physical and mental health problems can aggravate return to substance use (Binswanger et al., 2012; Johnson et al., 2013; Hser et al., 2007; Mallik-Kane & Visher, 2008). Qualitative explorations reveal that post-release relapse is often triggered by a myriad of intersecting barriers including negative affect (Bunting et al., 2018; Johnson et al., 2013), mental and physical health challenges (Binswanger et al., 2012; Johnson et al., 2013; Morash, 2010), environmental triggers (Bunting et al., 2018; Leverentz, 2013; Morash, 2010), and economic distress (Binswanger et al., 2012; Johnson et al., 2013) which can be considered in their relevance to vulnerable populations. The risk of relapse, including an accelerated return to use, is high among individuals with injection drug use (IDU) histories (Cepeda et al., 2015; DeBeck et al., 2009; Genberg, Astemborski, Vlahov, Kirk, & Mehta, 2015). It is important to consider the factors unique to vulnerable populations, especially those individuals reentering society, as they have unique barriers to reintegration which can exacerbate their return to substance use. Justice system involvement on its own may be associated with a shorter time to relapse (Hser et al., 2007).

3.1.2 Relapse among justice-involved individuals

Rates of opioid use among justice-involved populations are estimated at 16-25%, such that 1 in 4 females in prisons and jails and 1 in 6 males in prisons and jails report regular use of opioids prior to their incarceration (Bronson et al., 2017). An estimated 24-36% of all individuals with a heroin use disorder pass through the justice system in a given year (Boutwell, Nijhawan, Zaller, & Rich, 2007). Additionally, intensity of opioid use is related to more recent justice system involvement (Winkelman, Chang, & Binswanger, 2018). Relapse to opioids post-release has been found to occur in as many as 75% of formerly incarcerated (Fox et al., 2015; Kinlock,

Gordon, Schwartz, & O'Grady, 2008) as soon as 1-month post-release (Binswanger et al., 2013; Lee et al., 2015).

Justice systems seek to reduce post-release relapse through a variety of prison treatment modalities. A popular behavioral treatment is a therapeutic community (Chandler, Fletcher, & Volkow, 2009). Guided by De Leon (2000), prison and jail therapeutic communities are typically environmentally isolated communities which view substance use disorders from a whole-person perspective with the primary goal to change the negative behavior, thinking, and feeling patterns which precipitate substance use (De Leon, 2000; Inciardi, Martin, & Butzin, 2004). Therapeutic communities have demonstrated efficacy at reducing relapse (Inciardi et al., 2004). However, enrollment in aftercare is a critical component for positive outcomes, and diminished effects have been observed over time (de Andrade, Ritchie, Rowlands, Mann, & Hides, 2018; Inciardi et al., 2004).

3.1.3 Definitions of relapse

When considering occurrence of relapse, it is important to first discuss the theoretical and operational definitions of relapse and the term's use. Historically, substance use outcomes have tended to be dichotomous such that an individual is either abstinent and successful or relapsed and using (Miller, 1996). Dichotomous abstinent/relapse definitions imbue moral implications and fail to consider the gradual process of recovery (Miller, 1996; White & Ali, 2010.; White, 2007). Considering substance use on a continuum is more representative of the lives of individuals. For example, nicotine research has suggested trials measure prolonged abstinence after an initial period where returning to nicotine use is not considered a relapse (Hughes et al., 2003). Alcohol and nicotine research also consider relapse as measured by return to use for consecutive days, rather than a sole event (Chung & Maisto, 2006; Hughes et al., 2003).

Among opioid use, complete abstinence may often be advised as the ideal outcome given the deleterious effects of these substances. It is often considered that individuals with previous vulnerabilities may not be ideal candidates for a reduced use definition of recovery (White, 2007). Definitions in the late 1980s referred to recovery as "reduction of drug use, criminal involvement and unemployment" and "drug abuse and related behavior [that] are no longer problematic in the individual's life" (Simpson & Marsh, 1986; Leukefeld & Tims, 1986)- both definitions that do not require complete abstinence as measures of success. This distinction may be particularly important for PSU. Recovery programs and ideologies vary in terms of PSU relapse such that return to use of primary substance compared to return to use of any substance may trigger different support responses. Often motivations for PSU include the preferred effects produced by two or more substances (Ellinwood, Eibergen, & Kilbey, 1976; Leri, Bruneau, & Stewart, 2003). What constitutes a relapse in instances of PSU, then, is particularly ambiguous.

Given an emphasis on person-first language and autonomy of individuals as active agents in their own recovery (White & Ali, 2010), the current research allows individuals to determine if their post-release substance use is a relapse event. While the term 'relapse' may be better excluded and replaced, its use remains prevalent and particularly understood as part of peer recovery groups. Thus, when an individual reports that they have relapsed, they may be reporting that they have returned to problematic use as perceived in their own life.

3.1.4 Substances involved in relapse

The literature primarily focuses on relapse to preferred or primary substance, which makes it difficult to fully understand the array of substances that individuals use during a relapse event. When enrolled in treatment for a primary substance, individuals may turn to a new or secondary substance. For example, a study of individuals enrolled in methadone treatment found that approximately one-fourth began using benzodiazepines after entering treatment (Chen et al., 2011). Increased use of alcohol and marijuana has been found among individuals in their first

year of opiate abstinence (Bacchus, Strang, & Watson, 2000). Research indicates the role of the endocannabinoid system in opioid dependence (Bisaga et al., 2015), and increased use of marijuana during treatment for opioid use disorder has been observed (Heidebrecht, MacLeod, & Dawkins, 2018). There may be circumstances where individuals self-medicate to ease withdrawal symptoms, or individuals may replace their primary substance of use.

Examination of relapse within a polysubstance framework has not yet been explicitly explored. Life-course understandings of substance use find that periods of abstinence and use vary by substance (Hser et al., 2007). Given this heterogeneity, it is expected that experiences of relapse will vary when PSU is explicitly considered.

3.1.5 Current Research

The current study seeks to understand the risk factors associated with post-release relapse within consideration of PSU. While prior research has indicated high rates of post-release relapse for individuals who use opioids (Binswanger et al., 2013; Fox et al., 2015; Kinlock et al., 2008; Lee et al., 2015), it is unclear how PSU patterns in conjunction with relevant risk factors for justice populations influence post-release substance use. The goal of this study was to identify significant PSU opioid patterns which were used as independent predictors along with traditional and vulnerable domain factors from the Behavioral Model for Vulnerable Populations in a multivariate model of relapse in a justice-involved sample.

3.2 Methods

3.2.1 Sample

Data for the current study are from the Criminal Justice Kentucky Treatment Outcome Study (CJKTOS). The study is ongoing since 2005 and the current cohort is a 2015-2017 cohort consisting of both baseline and follow-up data as a result of a collaboration with the Department

of Corrections (DOC) and University of Kentucky Center on Drug and Alcohol Research (UK CDAR). Individuals entering DOC prisons, jails, and community custody are eligible for entry to substance abuse program (SAP). The SAP is a six-month program following the therapeutic community model (De Leon, 2000). Individuals are eligible for SAP if they have 12-24 months remaining to serve on their sentences, a reported substance use history, and no recent disciplinary violations. Individuals must provide consent to be included in the follow-up with contact information. Consent to baseline assessment is included in DOC consent to treatment and written consent at baseline is obtained for individuals who wish to be considered for the follow-up survey.

Baseline assessments are provided at entry by DOC staff using computer assisted personal interview (CAPI) software. UK CDAR uses telephone computer assisted personal interviewing software (CAPI) for a proportionate follow-up survey 12-months post-release. There were no significant differences between the greater SAP population and those included in the follow-up. Of the individuals who consent to follow-up, a random sample proportionate to the number of males and females released from prison, jails, and community custody programs are selected for inclusion with a yearly target sample of 350. Follow-up rates were 80% (2015), 83% (2016), and 84% (2017). Individuals were ineligible for follow-up if they moved out of state (n=31) or were deceased (n=13). The DOC receives an aggregated yearly report of findings, without individual data. A federal certificate of confidentiality was obtained and individuals were informed that their information would not be shared with the DOC.

The resulting sample for years 2015-2017 included 1,044 individuals. The sample was then limited to individuals from prison or jail SAP only (n=982), with a history of opioid use in the 12-months prior to incarceration (n=816), and who reported using more than one substance on a given day in the 30-days prior to incarceration (i.e., a PSU population) resulting in a final sample of 501 individuals.

3.2.2 Variables

3.2.2.1 Dependent Variables.

The primary outcome variable was a dichotomous measure of post-release relapse. Individuals who reported the use of any substances (any drugs and/or alcohol) in the 12-months post-release were asked if they considered their use to be a relapse (1=yes, 0=no to include no relapse or no substance use). An additional dependent variable measuring days until relapse through self-report of how many days an individual reported they were back in the community before they first used alcohol/drugs (0-365) was included for use in a time-series model.

3.2.2.2 Polysubstance Use Patterns.

The independent variables of polysubstance use patterns were measured through assignment to identified latent profiles. Previously (paper 1), these substances were used to form latent profiles in a larger sample of the CJKTOS population. Through the use of latent profile analysis, the larger study identified a six-profile model solution. The current research was interested to know if the six PSU opioid profiles previously identified existed in the current smaller population. Often referred to as validation, the replication of latent profiles is a common sensitivity analysis to determine if profiles exist in different samples (Pastor, Barron, Miller & Davis, 2007).

At baseline, individuals were asked if they had used a given substance in the 12-month prior to their incarceration. For each substance an individual reported using, they were then asked how many days in the 30-days prior to incarceration they used the substance (R: 0-30). The following substances were examined: alcohol, cocaine, marijuana, heroin, non-prescribed suboxone, non-prescribed opiates, amphetamines, and tranquilizers. Amphetamines included use of methamphetamine, MDMA, and non-prescribed Ritalin. Tranquilizers included non-prescribed use of benzodiazepines, ketamine, and muscle relaxers.

To validate the six-profile solution previously found, the posterior probabilities of profile membership from the baseline study were applied to the current sample of 501. The model successfully converged, and fit statistics indicate that the six-profiles were a best fit for the data (see Table 3.1). Further, the latent indicators of mean number of prior 30-day use were compared and the follow-up profiles remained the same in terms of substantive meanings and structure.

Once the latent profiles were validated, individuals were assigned to profiles based on their likelihood of membership (i.e., the three-step method). This membership is independent in that individuals can only belong to one profile. Characteristics of the PSU profiles are in Table 3.2. The six profiles were given descriptive profile titles. The Primarily Alcohol P1 profile consisted of individuals with near daily use of alcohol and co-use of marijuana and opiates. The Primarily Heroin P2 profile was characterized by near daily use of heroin along with co-use of marijuana and opiates. Individuals in the Low PSU P3 profile had lower use compared to other profiles but co-use of marijuana and opiates. The High PSU P4 profile was differentiated by diverse PSU to include near daily use of tranquilizers and high co-use of amphetamines. The Primarily Suboxone P5 profile contained individuals with near daily use of illicit suboxone and co-use of marijuana and opiates. The Stimulant-Opioid P6 profile was characterized by diverse PSU patterns to include near daily use of cocaine and co-use of marijuana, heroin, opiates, and tranquilizers.

3.2.2.3 Traditional Domain Variables.

All traditional domain variables were from baseline assessments. Utilizing the Behavioral Model for Vulnerable Populations (Gelberg et al., 2000) as a guiding framework, variables were categorized in the domains of predisposing, enabling, or need. Predisposing traditional domain variables included age (measured continuously), education (measured continuously with GED=12 years), race (1=white, 0=nonwhite), marital status (1=married, 0=single/divorced/widowed), and

gender (1=male 0=female). Pre-incarceration employment was considered dichotomously (1=unemployed).

The enabling traditional domain included a measurement of economic hardship. This was a summative scale adapted from the Survey of Income and Program Participation (R:0-8, α=0.87) which includes eight dichotomous measures of difficulty meeting needs of food, housing, clothing, and medical care (Beverly, 2001). Higher scores indicate more economic hardship.

The need traditional domain consisted of a dichotomous variable measuring individual's chronic pain as described to them as, "…pain persists or recurs for 3 months or longer. It typically includes pains like what you get from arthritis, fibromyalgia or unhealed injuries. It does not include minor headaches, or temporary pain from minor injuries." (1=yes). Pre-incarceration physical and mental health were considered via the questions, ""Thinking about your [physical/mental] health, which includes [physical illness and injury/stress, /depression and problems with emotions,] during the 30 days prior to this incarceration, how many days was your [physical/mental] health not good?" (R:0-30).

3.2.2.4 Vulnerable Domain Variables.

Variables in the vulnerable domain were from baseline assessments. The predisposing vulnerable domain included pre-incarceration homelessness (1=yes) and the number of years the individual was incarcerated. The county an individual lived in prior to incarceration was coded using a rural-urban coding scheme (Ingram & Franco, 2014) collapsed to a dichotomous measurement such that 1=rural and 0=urban.

The enabling vulnerable domain included a dichotomous measure indicating if the individual reported being told they had a learning disability. Recovery support was measured via a dichotomous question that asked, "In the 30 days prior to this incarceration, did you have

contact with family or friends who were supportive of your recovery?" The variable was coded such that a value of 1 indicated the individual had no recovery support.

Need vulnerable domain variables included lifetime injection drug use history (1=yes) and being told by a health professional they had the hepatitis c virus (HCV; 1=yes). Anxiety and depression symptoms in the 12-months prior to incarceration were measured using an adapted dichotomous version of the Patient Health Questionnaire-9 (PHQ-9; Spitzer, Kroenke, Williams, & Group, 1999) (R: 0-9), and the Generalized Anxiety Disorder-7 (GAD-7; Spitzer, Kroenke, Williams, & Löwe, 2006) (R:0-7). Scores above 2 would indicate a mild disorder, with increasing severity as scores increase. In the current study the internal reliability was strong for both scales, with PHQ-9 α=0.93 and GAD-7 α=0.97

3.2.3 Analytic Plan

Bivariate analyses of traditional and vulnerable domain variables using Fisher exact and ANOVA tests determined if PSU profiles were significantly different from each other in Table 3.3. Additionally, bivariate examination of the concept of relapse in the dependent variable are reported in Table 3.4. Fisher exact results examine the differences between individuals who report perceiving their substance use as a relapse (the dependent variable) and those who reported using a substance, but did not perceive their use to be a relapse.

Block-wise logistic regression examined the association between post-release relapse and (1) latent profiles, (2) traditional domain variables, (3) vulnerable domain variables with variables in block 2 and 3 only remaining in next block when significant at a conservative $p<.10$ or above for a (4) complete model. A secondary analysis examined the days until relapse using a Cox-proportional hazard model. In the Cox-proportional hazard model, individuals were right censored such that those not reporting relapse were given a value of 365 days. Five individuals report relapsing at 0 days, indicating they relapsed immediately after release. These individuals,

in order to be included in the Cox model which requires positive integers, were coded as having a relapse event at day 1. Supplementary analyses include bivariate Fisher's exact and t-tests for significant differences on the specific substance used post-release by latent profile. Tests for collinearity revealed no issues and variance inflation factors were less than 2.0. All analyses were performed with Stata (SE) 15.1.

3.3 Results

3.3.1 Characteristics of Sample

Sample characteristics are detailed in Table 3.3. The population was predominantly white, non-married males, who were on average age 33 with 13 years of education. The majority of participants reported unemployment prior to incarceration (64.87%). Individuals reported an average of two instances of economic hardship, on a scale ranging from zero to eight. Approximately one-third of the sample reported chronic pain, with an average week of poor physical health and 11 days of poor mental health in the 30-days prior to incarceration.

Nearly one in five participants were homeless prior to incarceration. Individuals were incarcerated an average of two years. The sample was nearly evenly split between rural and urban residents. One-fourth of the sample reported a learning disability. Nearly 30% stated they had no friends or family who were supportive of their recovery in the 30-days prior to incarceration. A majority (61.9%) reported IDU, and 14% reported HCV positive serostatus. On average, individuals met the criteria for mild to moderate depression and anxiety as indicated by average scores above the value of two. The total sample relapse rate was 40% with an average of 244 days until relapse (right-censored).

There were no significant differences between profiles on any of the traditional domain variables ($p>.05$). Among vulnerable domain variables, profiles were significantly different due to pre-incarceration homelessness ($p<.05$). Specifically, nearly 30% of Primarily Heroin P2 and

Stimulant-Opioid P6 individuals reported homelessness. Individuals also differed due to incarceration history such that Primarily Heroin P2 individuals were incarcerated for a shorter period than High PSU P4 (Tukey test $p<.05$). Profiles also differed significantly due to rural versus urban residence ($p<.001$). Primarily Heroin P2 lived in largely urban counties, compared with Primarily Suboxone P5 who largely lived in rural counties.

Significant differences were observed among IDU and HCV, such that Primarily Alcohol P1 had the lowest rates of both, while the Primarily Heroin P2 had greatest reports of both IDU and HCV. Profiles differed significantly in both depression and anxiety symptoms, and Tukey-Kramer tests performed after ANOVA indicated that these differences were significant between Low PSU P3 and High PSU P4. Additionally, significant differences of depression symptomology were found between High PSU P4 and Primarily Suboxone P5 ($p<.01$). The dependent variables of post-release relapse and days until relapse were also significantly different between profiles. The Low PSU P3 group was least likely to report a relapse, whereas Primarily Alcohol P1 and Primarily Suboxone P5 profiles were most likely to report post-release relapse. Post-hoc Tukey tests indicated that the Primarily Alcohol P1 group had significantly less days to relapse compared to the Low PSU P3 group.

Table 3.4 contains t-test and Fisher's exact test results for variables among those who considered their post-release substance use a relapse (n=203) and those who reported substance use post-release but did not consider it a relapse (n=87). Among latent profiles, a significance difference of $p<.01$ was found. Of note, all of the individuals in the Primarily Alcohol P1 group stated their post-release use was a relapse event.

Observing variables in the traditional domain, perceptions of whether post-release substance use was a relapse differed significantly by age, such that those who reported that it was a relapse were likely to be younger ($p<.05$). Additionally, individuals who perceived post-release use as relapse were more likely to have pre-incarceration recovery support ($p<.01$). In the

vulnerable domain, individuals with positive HCV serostatus were more likely to perceive their substance use as a relapse ($p<.01$). Further, among the dependent time variable, individuals who reported that post-release substance use was not a relapse had greater number of days until use ($p<.01$).

3.3.2 Multivariate Models Predicting Post-Release Relapse

Adjusted odds ratios for the stepwise logistic regression models examining association with post-release relapse are presented in Table 3.5. In Model 1, with latent profiles alone, the Primarily Alcohol P1 and Primarily Suboxone P5 groups were most likely to report relapse. This finding remained into the final model (Model 4). Three traditional domain variables were significant at the $p<.10$ level or above and remained into the full model: age ($p<.001$), gender ($p<.05$), and chronic pain ($p<.10$). Of vulnerable domain variables entered in Model 3, only HCV status ($p<.01$) was significant and remained into the full model.

Examining the full Model 4, individuals were more likely to report post-release relapse if they were characterized by Primarily Alcohol P1 PSU patterns (AOR: 2.80; $p<.01$) and Primarily Suboxone P5 (AOR: 2.39; $p<.01$) PSU patterns. With increasing age, individuals were less likely to report post-release relapse (AOR: 0.94; $p<.001$). Males had a 67% increased likelihood of relapse compared to females (AOR: 1.67; $p<.05$). Individuals who were HCV positive were also at increased risk of post-release relapse (AOR: 2.47; $p<.001$).

3.3.3 Days until Relapse

To further consider the relationship with PSU patterns and post-release relapse, Cox-proportional hazard models examined days until relapse (n=501, results not shown). The dependent variable remained the same but an additional factor of time to relapse was considered. Individuals were right-censored such that those who did not experience a relapse were given the value of 365 (max number of days in follow-up period). Results did not differ from the

multivariate models in Table 3.5, such that the Primarily Alcohol P1 (HR: 1.59, p<.05) and Primarily Suboxone P5 (HR: 1.38, p<.05) groups were at accelerated risk for relapse. Considered in conjunction with the results from Table 3.5, results indicate that not only are these profiles at risk for relapse, but they are at risk of relapsing sooner than other profiles (see Figure 3.2). The only significant covariate in the Cox-models was the traditional domain variable of age, such that being older reduced time to relapse (HR: 0.98; p<.01).

3.3.4 Supplementary Analyses

At follow-up, individuals were asked which substances they used in the previous 12 months since release. Table 3.6 contains the percentages and Fisher exact values for PSU profiles and post-release substance use. Significant differences at the p<.05 level or above are observed for post-release use of heroin (p<.001) and tranquilizers (p<.05). Specifically, the Primarily Heroin P2 group was most likely to report using heroin post-release and the Stimulant-Opioid P6 group reported highest use of tranquilizers. These substances align with prominent substance patterns observed in their pre-incarceration latent profiles.

Given that the Primarily Alcohol P1 and Primarily Suboxone P5 groups were most likely to report post-release relapse, examination of their post-release use is warranted. Approximately one-third of individuals characterized by Primarily Alcohol P1 reported post-release use of alcohol, marijuana, opiates, and amphetamines. Of the Primarily Suboxone P5 group, post-release use was largely characterized by alcohol, marijuana, suboxone, opiates, and amphetamine use.

3.4 Discussion

The current study explored the association of pre-incarceration PSU opioid patterns with post-release substance use. Guided by the Behavioral Model for Vulnerable Populations (Gelberg et al., 2000), findings indicate unique substance use, traditional, and vulnerable domain risk factors for return to substance use post-release. The relapse rate in the current justice-involved

population was 40% and ranged 34-58% by PSU profiles indicating heterogeneity by substance patterns. This rate is lower than post-release relapse rates found in other research (Fox et al., 2015; Kinlock et al., 2008) possibly owing to the treatment program individuals were enrolled in during their incarcerations.

Two PSU profiles were found to be at increased and accelerated risk for relapse. Thus, while some research has indicated risk factors are similar for relapse and proposed the relapse process to be similar across substances (Witkiewitz & Marlatt, 2004, 2007), the findings here support research which indicates recovery paths are likely to differ by substances (Castro, Barrington, Walton, & Rawson, 2000; Hser et al., 2007).

Primarily Alcohol P1 individuals had lower than average risk factors such as pre-incarceration homelessness, IDU histories, and HCV. However, individuals in this group were more likely to report relapse even when controlling for other risk factors. Of the individuals characterized as Primarily Alcohol P1, all reported their post-release use as a relapse compared to reporting use but no relapse.

Some research indicates individuals return to alcohol use may be influenced more by proximal risks- or immediate triggers-compared to distal risks (Witkiewitz & Masyn, 2008). In many individuals, posttreatment alcohol use tends towards dichotomy of abstinence or excessive use and the return to heavy drinking patterns occurs quickly among those who relapse (Hufford, Witkiewitz, Shields, Kodya, & Caruso, 2003). Returning to the community encompasses a myriad of difficulties which may serve as a proximal trigger. Alcohol use is the most commonly reported substance used by men returning to communities from prison (Mallik-Kane & Visher, 2008), perhaps owing to its legal status and the ease by which it can be obtained. The Primarily Alcohol P1 high pre-incarceration use of alcohol and high post-release reported use make this group highly vulnerable to post-release relapse.

The high rate of reported relapse, as opposed to return to use with no relapse, may be explained by the high presence of peer-recovery groups in prisons and jails and mandated as part of parole (Leverentz, 2013). The celebration of sobriety birthdays in programs such as Alcoholics Anonymous indicate a preference for abstinence, and individuals who have been involved in these programs may be more likely to self-cite relapse.

While the primary substance for Primarily Alcohol P1 was alcohol, it is important to highlight that this profile had moderate PSU of marijuana and opiates both pre and post-incarceration. Therefore, measuring their return to a primary substance (i.e., alcohol) may not have accurately captured their post-release relapse behavior. Rather, risk factors unique to alcohol use could have accelerated their return to use when combined with other high-risk substances. Marijuana is the second most frequently reported substance used post-release (Mallik-Kane & Visher, 2008) and relapse to opiates is high as well (Fox et al., 2015) making this profile of PSU individuals highly vulnerable.

The Primarily Suboxone P5 profile were also more likely to have a post-release relapse event, and at accelerated rate. This profile was unique in individuals' near daily use of illicit Suboxone as well as co-use of marijuana and opiates. These substances were also reported post-release. Individuals in this profile were unique in that they were more likely to live in rural areas compared to the other profiles. It is likely that this influenced their preferred substance patterns (Young, Havens, & Leukefeld, 2010).

Motivations for illicit buprenorphine use includes support for both euphoric effects as well as self-treatment of opioid dependence (Bazazi, Yokell, Fu, Rich, & Zaller, 2011; Hakansson, Medvedeo, Andersson, & Berglund, 2007; Yokell, Zaller, Green, & Rich, 2011). However, it is unclear why return to illicit Suboxone would occur post-treatment. As of 2015 the KY DOC began offering injectable naltrexone to individuals enrolled in SAP. Individuals with pre-incarceration preference for Suboxone may continue to prefer Suboxone as a treatment

modality post-release, or their use may have been unrelated to curbing opioid withdrawal. Given Suboxone's primary use as a treatment modality for opioid use disorder, less is known about the recovery trajectories of individuals who primarily report illicit Suboxone use.

Considering the Behavioral Model for Vulnerable Populations (Gelberg et al., 2000), traditional domain variables of age and gender were significantly associated with post-release relapse. Substantial literature exists to support these relationships (Evans et al., 2009; Kopak et al., 2016; Walitzer & Dearing, 2006). In the vulnerable domain, HCV status was a robust predictor of post-release relapse. Complex physical health problems can exacerbate reentry difficulties (Binswanger et al., 2012). HCV is typically prevalent among individuals with more extensive substance use histories (Klinkenberg et al., 2003; Rosenberg, Drake, Brunette, Wolford, & Marsh, 2005; Shapatava, Nelson, Tsertsvadze, & Rio, 2006), and this previous history may indicate individuals are more likely to return to use. Further, there are risky behaviors correlated with HCV serostatus (Koblin, Factor, Wu, & Vlahov, 2003; Vescio et al., 2008; Willner-Reid, Belendiuk, Epstein, Schmittner, & Preston, 2008), and its significance may reflect underlying latent variables.

The current research made contributions to previous literature on relapse through the focus on a high-risk criminal justice sample and the use of longitudinal data. This study is also unique given the focus on PSU opioid patterns and highlighting the importance of PSU in the relapse literature. There are, however, limitations to consider. The data included are based on self-reports from a justice-involved sample. While this allowed for a unique definition of relapse with more autonomy, it is plausible that the amount of substance use is underreported. While the University oversees the follow-up data collection, it is possible individuals still feared negative consequences from the DOC for reporting illegal behavior at follow-up.

In the current study, PSU is operationalized as regular interval use among a PSU sample. That is, while individuals had self-reported histories of using more than one substance on a given

day, the latent profiles captured regular interval PSU and were not able to measure simultaneous or sequential PSU patterns. Future research should consider these patterns when examining follow-up outcomes. The current study provided insights into the patterns of use associated with relapse but leaves motivations and contextual understandings of relapse unexplored. Future qualitative research that explores the motivations for pre-incarceration PSU as well as more specific details about post-release relapse would be beneficial so as to design effective interventions.

3.4.1 Conclusions

The findings of the current study indicate that among users of opioids who return to the community after prison, there is a continuum of risk. Elevated risk of relapse among individuals who co-use marijuana and opiates with alcohol or illicit Suboxone were found. Understanding individuals' pre-incarceration patterns of PSU may assist in mitigating risk to relapse post-release if appropriate interventions are made available. Findings indicate significant heterogeneity among PSU justice-involved populations and the period of incarceration provides opportunity to implement targeted interventions and provide aftercare planning. Further, both traditional and vulnerable domains of the Behavioral Model for Vulnerable Populations provided significant predictors indicating the utility of considering this model for post-release relapse in future research. The reduction of post-release substance use improves outcomes for the lives of individuals, along with cost-savings for communities and justice systems.

Table 3.1 Fit statistics for latent profile validation analysis

	6,569 Baseline Sample		501 Follow-Up Cohort	
Number of Profiles	AIC	BIC	AIC	BIC
1	409677.5	409786.1	30960.7	31028.2
2	402295.7	402465.5	30073.9	30179.3
3	400521.7	400752.6	29921.7	30065.0
4	400005.1	400297.1	30231.8	30413.1
5	394654.1	395007.2	30127.9	30347.1
6	**393898.7**	**394312.9**	**29810.8**	**30068.0**

Notes: AIC= Akaike's information criterion; BIC= Bayesian Information criterion; bolded indicates selected latent profile

Table 3.2 Latent profile conditional means for polysubstance opioid use (n=501)

	Profile 1	Profile 2	Profile 3	Profile 4	Profile 5	Profile 6
Descriptive profile abbreviation	Primarily Alcohol P1	Primarily Heroin P2	Low PSU P3	High PSU P4	Primarily Suboxone P5	Stimulant -Opioid P6
Latent Profile indicators: Prior 30- day use						
Alcohol	27.66	3.81	2.80	10.27	6.15	8.68
Cocaine	3.08	1.25	0.62	1.97	1.22	28.13
Marijuana	13.95	11.24	11.98	13.68	13.67	14.90
Heroin	1.77	28.85	0.89	7.45	1.94	13.55
Suboxone	1.45	2.71	1.41	9.36	28.49	7.97
Opiates	11.14	15.14	16.51	19.79	13.30	17.21
Amphetamines	6.82	5.77	8.09	9.84	8.37	6.09
Tranquilizers	2.85	4.29	2.77	28.71	4.23	11.11
Profile Prevalence	6.19%	15.97%	42.91%	15.17%	8.58%	11.18%

Note: shading highlights most prevalent substances

Table 3.3 Characteristics of study population (n=501)

	Total Sample	Primarily Alcohol P1	Primarily Heroin P2	Low PSU P3	High PSU P4	Primarily Suboxone P5	Stimulant -Opioid P6	p-value
Traditional Domain								
Age	32.55 (7.67)	33.84 (8.61)	30.54 (6.71)	32.99 (7.70)	33.33 (8.82)	31.81 (6.97)	32.55 (6.91)	.14
Education level	11.87 (2.13)	12.06 (1.65)	11.77 (2.10)	11.83 (2.17)	12.21 (2.53)	11.65 (1.97)	11.78 (1.81)	.70
White	84.83	77.42	90.00	86.05	86.84	83.72	75.00	.17
Unemployed	64.87	70.97	38.75	34.42	35.53	20.93	46.43	.16
Male	72.65	80.65	68.75	72.09	67.11	79.07	78.57	.62
Married	21.36	12.90	22.50	20.93	19.74	30.23	21.43	.45
Economic hardship	2.10 (2.52)	2.42 (2.78)	2.24 (2.75)	1.91 (2.40)	2.25 (2.57)	1.70 (2.11)	2.61 (2.67)	.34
Chronic pain	30.34	32.26	26.25	29.30	44.74	23.26	25.00	.07
Physical health days	7.40 (11.97)	9.42 (13.45)	7.15 (12.12)	6.47 (11.35)	9.25 (12.88)	8.32 (12.03)	6.96 (12.01)	.50
Mental health days	11.54 (13.80)	13.52 (14.15)	12.52 (14.30)	10.12 (13.32)	15.31 (14.21)	9.51 (13.83)	10.91 (13.54)	.07
Vulnerable Domain								
Homeless	20.16	16.13	28.75	14.42	23.68	16.28	30.36	.02
Years incarcerated	2.23 (1.74)	2.60 (2.36)	1.71 (1.25)	2.21 (1.72)	2.61 (1.54)	2.17 (1.46)	2.41 (2.23)	.02
Rural	52.69	58.06	23.75	59.53	56.58	79.07	39.29	.001
Learning disability	25.75	29.03	28.75	21.40	26.32	34.88	28.57	.44
No recovery support	29.74	29.03	30.00	30.23	31.58	25.58	28.57	.99
IDU	61.88	48.39	81.25	50.70	71.05	65.12	69.64	.001
HCV	14.17	9.68	23.75	9.77	18.42	18.60	10.71	.03
Depression	4.44 (3.52)	4.26 (3.55)	5.07 (3.43)	4.01 (3.53)	5.61 (3.31)	3.35 (3.48)	4.55 (3.46)	.002
Anxiety	3.71 (3.23)	3.84 (3.36)	3.51 (3.18)	3.30 (3.22)	4.68 (3.12)	3.74 (3.32)	4.14 (3.15)	.03
Dependent Variables								

Table 3.3 (continued)

	Total Sample	Primarily Alcohol P1	Primarily Heroin P2	Low PSU P3	High PSU P4	Primarily Suboxone P5	Stimulant-Opioid P6	p-value
Post relapse	40.52	58.06	41.25	34.42	40.79	58.14	39.29	.03
Days until relapse (Right-censored)	244.35 (153.15)	173.64 (169.01)	245.79 (152.60)	261.37 (148.07)	249.43 (148.87)	191.28 (156.07)	249.95 (154.42)	.01

Note: p-values obtained through ANOVA and Fisher exact tests

Table 3.4 Examination of dependent variable: post-release relapse vs. post-release substance use

	Post-release relapse reported (N=203)	Substance use, but no relapse (N=87)	p-value
Latent Profiles			.01
Primarily Alcohol P1	100.0	0	
Primarily Heroin P2	70.21	29.79	
Low PSU P3	64.35	35.65	
High PSU P4	67.39	32.61	
Primarily Suboxone P5	86.21	13.79	
Stimulant-Opioid P6	62.86	37.14	
Traditional Domain			
Age	30.93 (7.54)	33.14 (8.28)	.03
Education level	12.72 (1.86)	13.07 (2.41)	.18
White	87.19	82.76	.36
Unemployed	65.52	60.92	.50
Male	76.85	78.16	.88
Married	21.67	19.54	.75
Economic hardship	2.01 (2.52)	2.21 (2.45)	.54
No recovery support	25.62	42.53	.01
Chronic pain	31.03	31.03	1.0
Physical health days	7.39 (11.94)	8.22 (12.87)	.60
Mental health days	11.62 (13.79)	10.69 (13.88)	.60
Vulnerable Domain			
Homeless	18.23	22.99	.42
Years incarcerated	1.59 (1.60)	1.25 (1.24)	.07
Rural	53.69	44.83	.20
Learning disability	27.09	27.59	1.0
IDU	66.50	60.92	.42
HCV	18.72	6.90	.01
Depression	4.39 (3.48)	3.92 (3.52)	.42
Anxiety	3.84 (3.24)	3.38 (3.23)	.26
Dependent Variables			
Post relapse	--	--	
Days until relapse (Right-censored)	67.24 (71.13)	99.78 (102.33)	.002

Note: p-values obtained through t-tests and Fisher's exact tests

Table 3.5 Stepwise logistic regression predicting post-release relapse; Adjusted odds ratios (standard errors) reported (n=501)

	Model 1	Model 2	Model 3	Model 4
Latent Profiles				
Primarily Alcohol P1	2.64**	2.94**	2.78**	2.80**
Primarily Heroin P2	1.34	1.18	1.16	1.06
High PSU P4	1.31	1.32	1.15	1.20
Primarily Suboxone P5	2.65***	2.57**	2.29*	2.39**
Stimulants-Opioid P6	1.23	1.23	1.22	1.19
Traditional domains				
Age		0.94***	0.93***	0.94***
Education level		0.94	--	
White		1.48	--	
Unemployed		0.90	--	
Male		1.55	1.60*	1.67*
Married		1.08	--	
Economic hardship		0.98	--	
No recovery support		0.74	--	
Chronic pain		1.46	1.46	1.44
Physical health days		1.00		
Mental health days		1.00		
Vulnerable domains				
Homeless			0.72	
Years incarcerated			1.08	
Rural			1.12	
Learning disability			0.95	
IDU			1.17	
HCV			2.33**	2.47***
Depression			0.98	
Anxiety			1.04	
	12.71*	40.85***	49.74***	44.30***
	0.0188	0.0604	0.0735	0.0655

Note: Latent profile 3, low PSU is reference group; stepwise technique includes variables significant in previous model at p<.10 remain into next model; significance indicated by *p<.05, **p<.01, ***p<.001

Table 3.6 Post-release substances used (%) among those reporting relapse by latent profile (n=203)

	Alcohol	Cocaine	Marijuana	Heroin	Suboxone	Opiates	Amphetamines	Tranquilizers
Primarily Alcohol P1	29.03	3.23	22.58	12.90	16.13	29.03	32.26	0.00
Primarily Heroin P2	31.25	11.25	28.75	41.25	16.25	43.75	17.50	13.75
Low PSU P3	25.12	4.65	27.44	9.30	13.49	26.98	20.93	6.98
High PSU P4	28.00	8.00	24.00	9.33	16.00	29.33	10.67	13.33
Primarily Suboxone P5	34.88	2.33	39.53	6.98	27.91	41.86	25.58	4.65
Stimulant-Opioid P6	32.14	12.50	23.21	23.21	16.07	32.14	25.00	16.07
p-value	.71	.11	.47	.001	.37	.08	.09	.03

Note: p-values obtained through Fisher's exact tests

Figure 3-1 Behavioral Model for Vulnerable Populations (Gelberg, Andersen, & Leake, 2000) as applied in current research

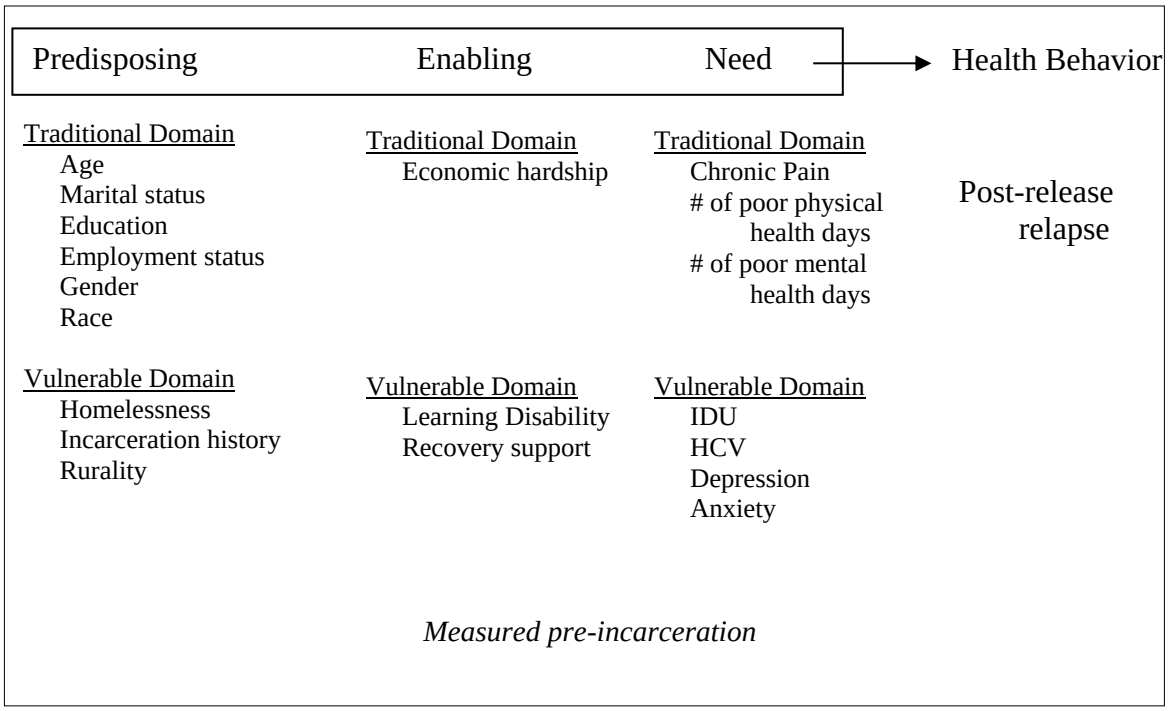
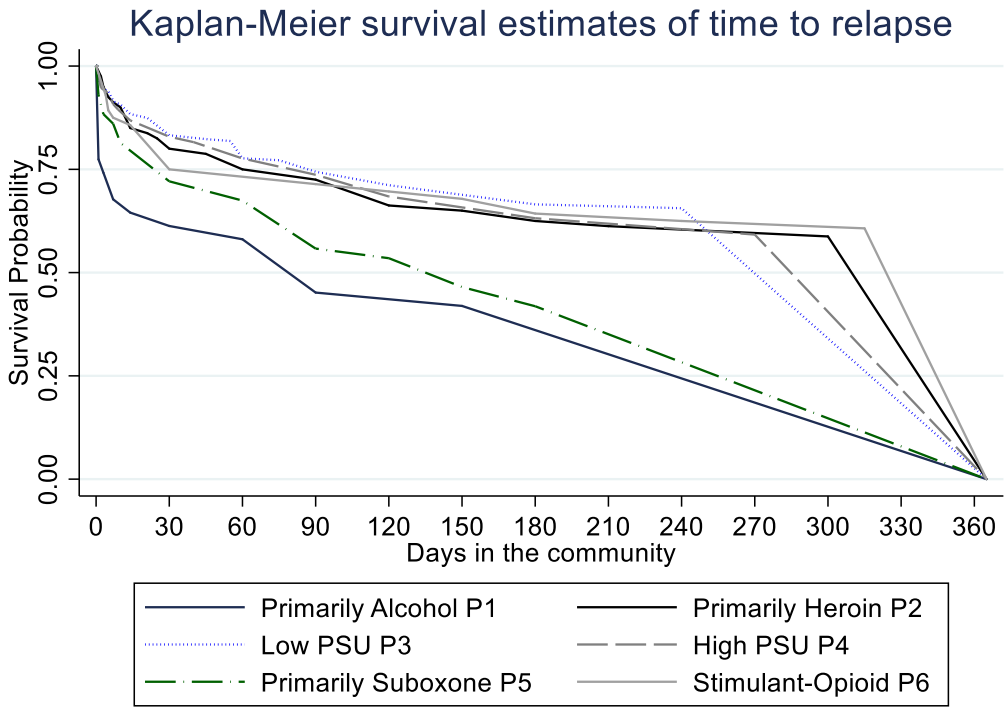


Figure 3-2 Days until relapse by latent profile



CHAPTER 4. POST-RELEASE HEALTH SERVICE UTILIZATION: AN APPLICATION OF THE BEHAVIORAL MODEL OF VULNERABLE POPULATIONS TO A POLYSUBSTANCE POPULATION (PAPER 3)

4.1 Introduction

Substance use and justice-involvement are inextricably linked, such that the majority of justice-involved individuals meet the criteria for substance use disorder (Bronson, 2017). Specifically, the prevalence of opioid use disorder in prisons and jails is pronounced. More than half of individuals with prescription opioid use disorder and over 75% of individuals reporting past year heroin use have prior justice-involvement (Winkelman, Chang, & Binswanger, 2018). Post-release rates of relapse and risk of overdose are high (Binswanger, Blatchford, Mueller, & Stern, 2013; Binswanger et al., 2007). Further complicating the intersection of justice-involvement with substance use is polysubstance use (PSU) or the consumption of more than substance during the same timeframe.

PSU is common among justice populations, as 30-74% of currently incarcerated populations report using more than one substance prior to their incarceration (Kubiak, 2004; Lo & Stephens, 2000). Patterns of PSU continue to be observed post-release such that 56% of overdoses among a sample of recently released individuals involved PSU. While justice-involved populations have higher rates of mental and physical health problems compared to general populations (James & Glaze, 2006; Mallik-Kane & Visher, 2008), PSU populations have marked histories as well (Betts et al., 2015; Carlson et al., 2014; Darke & Hall, 1995; Feaster et al., 2016; Quek et al., 2013) indicating that these comorbidities may be more pronounced among justice-involved populations with PSU histories.

Previous research indicates that formerly justice-involved populations are prodigious consumers of health care, most notably cost-intensive services such as emergency room (ER) care (Leukefeld, et al., 2006; McCorkel, et al., 1998; Schnittker, Uggenm Shannon, & McElrath, 2015). Frequent utilizers of ER care make up 4-8% of the ER population, yet 21-28% of ER visits

(Schnittker et al., 2015). While individuals who use substances have pronounced health needs, the use of ER services in lieu of a regular source of care is costly and creates health service gaps furthering poor health outcomes among this population (Laine et al., 2001). A study of individuals with substance use histories in Tennessee found an estimated $777 million in extra ER charges due to increased ER use among the studied population (Rockett, Putnam, Jia, Chang, & Smith, 2005). Further, individuals with poorer health status are more likely to engage in post-release care (Leukefeld, et al., 2006). Given the higher comorbidity of mental and physical health problems among PSU populations, the examination of post-release service utilization among this population is warranted.

Justice-involved PSU populations represent a vulnerable population, when considering their pronounced risk for poor outcomes. The post-release consumption of health care among this population is important to examine, within a framework that considers their unique vulnerabilities. The overall purpose of this study is to utilize the Behavioral Model for Vulnerable Populations to examine the utilization of two health services (ER care, outpatient) 12-months post-release given pre-incarceration PSU patterns.

4.1.1 Behavioral Model for Vulnerable Populations

The Behavioral Model for Vulnerable Populations (Gelberg, Andersen, & Leake, 2000) is a revised version of the 1960's Behavioral Model (Andersen, 1968) adapted to consider the factors relevant to vulnerable populations (Aday, 1994). Factors are considered based on their relevance to the current vulnerable population being considered. The framework consists of three categories of factors: predisposing, enabling, and need, that are divided into two domains, traditional and vulnerable, as relevant to general and vulnerable populations as predictors of health service utilization (see Figure 4.1).

Predisposing factors refer to those that exist before health needs, such as sociodemographic variables and values. In the traditional domain, this would include age, education, race, employment status, gender, or marital status. Previous research has found older individuals (Gelberg et al., 2000, 2012; Varga & Surratt, 2014), those with higher education (Pullen, Perry, & Oser, 2014; Varga & Surratt, 2014), and married individuals are more likely to access care, indicating the utility of considering predisposing traditional domain variables.

Predisposing factors in the vulnerable domain are specific to justice-involved or substance using populations in the current research. Homelessness (Kushel, Perry, Bangsberg, Clark, & Moss, 2002) and incarceration history (Gelberg et al., 2012; Kulkarni et al., 2010; Nowotny, 2017; Webster et al., 2006) are associated with decreased access to routine health services, yet associated with increased ER utilization (Kim, Kertesz, Horton, Tibbetts, & Samet, 2006; Kushel et al., 2002; Stein, Andersen, Robertson, & Gelberg, 2012). Further, rurality is associated with diminished access to health services (Webster et al., 2006), and serves as a predisposing vulnerable variable in the current study.

Enabling factors reference elements that affect the ability of the population to secure resources or care. Enabling traditional factors include income and economic distress, such that individuals with greater economic need are less likely to have access to care (Gelberg et al., 2000; Kushel et al., 2001; Teruya et al., 2010). In the vulnerable domain, enabling factors can include measures of social support. The relationship between support and health service utilization is not as clear, with research finding mixed results of both increased (Nowotny, 2017; Pullen et al., 2014; Weinreb et al., 2006) and decreased access to care (Pullen et al., 2014). Further, the current research considers learning disability as an enabling vulnerable variable, given the pronounced prevalence of learning disabilities among justice-involved populations (Freudenberg, 2001) which may affect their ability to navigate complex health care systems. Previous research indicates decreased utilization of health services among individuals with developmental or intellectual

disabilities (Havercamp, Scandlin, & Roth, 2004; Sowney & Barr, 2004), yet the effect of learning disability among justice population's use of health services remains unexplored.

Need factors refer to the perceived and actual health problems of traditional and vulnerable populations. In the traditional domain this has previously included measurements of self-rated health or chronic health conditions (Varga & Surratt, 2014). More relevant to the current population, need vulnerable factors would include mental health problems and infectious diseases such as hepatitis C virus (HCV) (Gelberg et al., 2012). Given the correlation between injection drug use (IDU) and infectious diseases (Van Handel et al., 2016), consideration of IDU within the need vulnerable domain is also warranted. Previous research indicates need factors in both the vulnerable and traditional domains to be important correlates of health care access (Brubaker et al., 2013; Gelberg et al., 2012; Oser et al., 2016; Nowotny, 2017; Rhoades et al., 2014; Teruya et al., 2010; Varga & Surratt, 2014; Webster et al., 2006).

The predictive validity of the traditional and vulnerable domains has been found to vary according to the health service examined (Katerndahl & Parchman, 2002; Oser et al., 2016; Varga & Surratt, 2014; Victor et al., 2018). For example, many of the factors associated with a decreased access to outpatient care (e.g., incarceration history, comorbid health problems) are significant predictors of increased emergency room utilization (Frank, Linder, Becker, Fiellin, & Wang, 2014; Kushel et al., 2002). While the utility of the domains is clear from prior research, it remains to be seen how PSU affects health care utilization.

The post-release period includes a heightened risk of death for justice-involved populations (Binswanger et al., 2007; Spaulding et al., 2011). Not only are individuals at increased risk for overdose (Binswanger et al., 2007, 2013), but death due to health problems of human immunodeficiency virus (HIV), cancer, and liver cirrhosis account for excess mortality among previously incarcerated populations (Spaulding et al., 2011). The post-release period is fraught with struggles which often supersede the continuity of health care, such as securing

housing, or are in themselves barriers to receiving health care, such as unemployment (Dumont, Brockmann, Dickman, Alexander, & Rich, 2012). It is a pressing concern to understand the factors associated with the utilization of post-release health services.

4.1.2 Current research

The current study contributes to previous literature by examining the health service utilization 12-months post-release among a cohort of polysubstance-opioid using individuals. While the Behavioral Model for Vulnerable Populations (Gelberg et al., 2000) has examined post-incarceration health service utilization, its use remains limited among this population and has been most often examined among specialty subgroups including women (e.g., Oser et al., 2016; Victor et al., 2018) and HIV-subpopulations (e.g., Goshin & Byrne, 2012; Krishnan et al., 2013; Meyer, Qiu, Chen, Larkin, & Altice, 2012). In the current opioid epidemic, where the majority of opioid overdoses are due to PSU (Ruhm, 2017), understanding the factors which link vulnerable populations to health care is a pressing public health concern. To that end, the current research aims to (1) examine pre-incarceration PSU opioid patterns as predictors of post-release health service utilization, and (2) identify the significant correlates of traditional and vulnerable domains as predictive of post-release emergency room and outpatient care. It is expected that PSU patterns that are associated with poor mental and physical health comorbidities will engage in post-release care, most notably ER care. It is also hypothesized that vulnerable domains will be robust predictors of post-release service utilization.

4.2 Methods

4.2.1 Sample

Data from the current sample are from the Criminal Justice Kentucky Treatment Outcome Study (CJKTOS). The study is a state-mandated treatment outcome study of Department of Corrections (DOC) substance abuse programming (SAP), ongoing since 2005 in

conjunction with the University of Kentucky's Center on Drug and Alcohol Research. The SAP is available to individuals in KY prison, jails, and community custody programs with a self-report of substance use history and 24-months remaining before parole or release. The program is 6-months in duration and follows a therapeutic community model of treatment (De Leon, 2000).

Within the first two weeks of entering SAP, a baseline assessment is given by trained DOC staff. Consent to baseline assessment is part of the DOC consent to treatment. During the baseline assessment, individuals are asked about their desire to take part in a follow-up survey and provide consent to be contacted along with follow-up information. Twelve months post-release, a proportionate stratified sample of those who consented to follow-up are contacted via telephone for an interview by university staff using computer assisted software. There were no significant differences between the SAP population as a whole and those included in follow-up. Among individuals who consent to follow-up, a random sample proportionate to the number of males and females released from each institution are selected for inclusion with a yearly target of 350 individuals. Follow-up rates were 80% (2015), 83% (2016), and 84% (2017). Persons were ineligible for follow-up if the moved out of the state or were deceased. All data were encrypted, and a certificate of confidentiality was obtained. The study is approved by the University Institutional Review Board.

The current sample included individuals from the 2015-2017 follow-up surveys, and their linked baseline assessment information, for a total of 1,044 individuals. The sample was limited to persons who participated in prison or jail-based SAPs (n=982). Further, individuals had to have reported the use of an opioid (i.e., heroin, nonprescribed prescription opiate, illicit suboxone or methadone) in the 12-months prior to incarceration and must have reported using more than one substance in the 30-days prior to incarceration (e.g., polysubstance use). The final sample included 501 individuals who met the study inclusion criteria.

4.2.2 Measures

Variables measuring polysubstance use, traditional, and vulnerable domains were from the baseline assessment data. The health care utilization variables were from follow-up assessments conducted 12-months post-release.

4.2.2.1 Polysubstance use variables.

Polysubstance use was measured through the use of latent profiles. Continuous variables measuring the number of days in the 30-days prior to incarceration individuals engaged in the use of alcohol, cocaine, marijuana, heroin, nonprescribed prescription opiates, illicit suboxone, amphetamines, and tranquilizers were included in the creation of latent profiles. The profiles used in the current sample were obtained through replication of a prior larger baseline-only sample from CJTKOS (see paper 1) where a six-profile solution was identified. Posterior probabilities from the previously identified profiles were applied to the current data in order to determine if the profiles replicate, a process referred to as validation (Pastor, Barron, Miller, & Davis, 2007).

The six-profile model successfully converged, and fit indices indicated that this model was the best fit for the current data (see Table 4.1). Examination of the profiles indicated that they remained the same in terms of substantive meaning and structure from the six-profiles identified in the earlier study. Individuals were assigned to their profile of most likely membership, and membership is independent in that individuals could not belong to more than one profile. The final six profiles include: Primarily Alcohol, Primarily Heroin, Low PSU, High PSU, Primarily Suboxone, and Stimulant-Opioid (see Table 4.2).

Profiles were given a descriptive profile abbreviation which are used to refer to the profiles in the remainder of the research. Profile 1, Primarily Alcohol P1, described 6.2% of the sample and was characterized by near daily alcohol use with co-use of marijuana and opiates. Approximately 16% of the sample was characterized by Primarily Heroin P2, with predominately

heroin use and co-use of marijuana and opiates. The largest profile (42.9%) was Low PSU P3 whom did not have near daily use of any substances but somewhat regular use of marijuana and opiates. Profile 4, with 15% of the sample, was characterized by High PSU of opiates and near daily use of tranquilizers along with co-use of alcohol and marijuana. The Primarily Suboxone P5 profile (8.6%) included near daily use of illicit suboxone and co-use of marijuana and opiates. Lastly, Stimulant-Opioid P6 described the near daily cocaine and co-use of opiates, heroin, and marijuana indicated by 11% of the sample in profile six.

4.2.2.2 Traditional domain variables.

4.2.2.2.1 PREDISPOSING.

Age was measured continuously. Marital status was collapsed such that married was compared to all other statuses. Education was measured continuously, with GED equivalating 12th grade completion. Pre-incarceration employment status was dichotomous such that unemployed=1. Gender (1=male) and race (1=white) were measured dichotomously.

4.2.2.2.2 ENABLING.

Pre-incarceration income was not available, however a measurement of economic hardship was included. A summative scale of eight indicators (1=yes, 0=no) adapted from the Survey of Income and Program Participation (Beverly, 1999; 2001) measuring 12-month prior to incarceration hardships such as, “Did you or someone in your household need to see a doctor or go to the hospital but weren’t able to because of financial reasons?” The scale includes five items measuring difficulty meeting basic living and three items measuring difficulty affording health care (R:0-8, α=0.87).

4.2.2.2.3 NEED.

Measures of health statuses were included. Chronic pain history was measured dichotomously (1=yes) via a question: “Chronic pain persists or recurs for 3 months or longer. It typically includes pains like what you get from arthritis, fibromyalgia or unhealed injuries. It does not include minor headaches, or temporary pain from minor injuries. Have you had serious chronic pain persisting or recurring for 3 months or longer during the 12 months prior to this incarceration?” The number of poor mental health days and physical health days were measured continuously by asking individuals about the number of days in the 30 days prior to incarceration their physical health and mental health (separately) were not good.

4.2.2.3 Vulnerable domain variables.

4.2.2.3.1 PREDISPOSING.

Pre-incarceration homelessness was dichotomously measured (1=yes). The length of each individual’s incarceration was calculated. Rurality was measured using the National Center for Health Statistics urban-rural coding scheme (Ingram & Franco, 2004) to code the county individuals lived in prior to incarceration. These were dichotomized (rural=1) such that counties with populations more than 250,000 were considered urban (urbanization levels: large metro, central & fringe, medium metro), compared to smaller counties (urbanization levels: small metro, micropolitan, noncore).

4.2.2.3.2 ENABLING.

Individuals self-reported if they had a learning disability (1=yes). Recovery support was measured dichotomously (1=yes) via the question; “In the 30 days prior to this incarceration, did you have contact with family or friends who were supportive of your recovery?”

4.2.2.3.3 NEED.

Injection drug use was measured dichotomously regarding lifetime history (1=yes). HCV was self-reported (1=yes). Depression was measured using a modified dichotomous version of the Patient Health Questionnaire-9 (R:0-9, α= 0.93). Anxiety was measured via a modified dichotomous version of the Generalized Anxiety Disorder-7 (R: 0-7, α=0.97).

4.2.2.4 Health care utilization variables.

Two follow-up variables measured health care utilization dichotomously. Specifically, the use of the emergency room and outpatient care in the 12-months post-release were included as the dependent variables of interest.

4.2.3 Analytic plan

Descriptive and bivariate statistics were examined on all variables of interest and are included in Table 4.3. Fisher's exact and ANOVA tests examine the significance of the variables by the polysubstance latent profiles. Variable selection techniques were used for multivariate models. Variables significantly correlated with either of the outcome variables in a correlation matrix (not shown) at the $p<.05$ level were included in the models.

Multivariate logistic regression models were used to predict emergency room visits (Table 4.4) and outpatient visits (Table 4.5) using a stepwise technique. The stepwise approach enters latent profiles first, followed by traditional domain variables, and vulnerable domain variables as the full model. All analyses were completed using Stata 15.1 SE. Tests of multicollinearity revealed no issues with variance inflation factors less than 2.0. Final models were significant and provided best model fit.

4.3 Results

4.3.1 Descriptive and bivariate statistics

Table 4.3 includes descriptive statistics with results from Fisher's exact and ANOVA tests. On average, individuals were 33 years old, with 12 years of education, white, and unemployed prior to incarceration. The sample was primarily male. Approximately one-fifth were married. Individuals reported an average of two economic hardships. Nearly one-third reported chronic pain prior to incarceration. Individuals reported an average of 7 days of poor physical health and 12 days of poor mental health, with substantial variation as evident by the standard deviations.

One-fifth of the sample was homeless prior to incarceration. Individuals were incarcerated an average of two years. Half of the sample lived in rural counties prior to incarceration. One-quarter of the sample reported a learning disability and 30% reported having no contact with friends or family who were supportive of their recovery. The majority (61.9%) had lifetime histories of IDU. Fourteen percent self-reported HCV. Individuals, on average, met the criteria for mild to moderate depression and anxiety as indicated by PHQ-9 and GAD-7 scores (Spitzer, Kroenke, Williams, & Group, 1999; Spitzer, Kroenke, Williams, & Löwe, 2006). Emergency room utilization was engaged by 45% of the sample, and 42% reported outpatient visits in the 12-months after release.

In order to better understand the intersection of PSU and health, all variables were examined by PSU profile. Fisher's exact and ANOVA tests examine significant bivariate differences across profiles. Post-hoc Tukey tests after significant ANOVA results were also explored. Profiles were not significantly different on any of the traditional domain variables. Significant differences were found on vulnerable domain variables.

Specifically, individuals in the Primarily Heroin P2 and Stimulant-Opioid P6 profiles were more likely to be homeless ($p<.02$). Tukey results indicated significant differences of incarceration length among the Primarily Heroin P2 and High PSU P4 profiles ($p<.05$). The Primarily Heroin P2 profile was least likely to live in a rural county prior to incarceration (24%), while the Primarily Suboxone P5 profile was most likely to live in a rural county prior to incarceration (79%; $p<.001$). Significant differences of IDU history existed such that the Primarily Alcohol P1 and Low PSU P3 profiles were less likely to report IDU ($p<.001$). These profiles were additionally less likely to report HCV serostatus ($p<.03$).

Significant differences existed between profiles on both mental health variables of depression and anxiety. The Low PSU P3 and High PSU P4 profiles differed significantly on both variables ($p<.05$), such that the High PSU P4 profile had greater symptomology. The High PSU P4 profile also had significantly greater depression symptoms when compared to the Primarily Suboxone P5 profile in post-hoc tests ($p<.05$).

Additional significant differences were found by profile's post-release utilization of ER care. Post-release care utilization indicated that the High PSU P4 and Stimulant-Opioid P6 profiles utilized the ER most often. Profiles did not significantly differ by outpatient care utilization.

4.3.2 Multivariate models

Tables 4.4 and 4.5 contain multivariate logistic regression models predicting post-release service utilization. Latent profiles were entered first, followed by relevant traditional and vulnerable domain variables. In the bivariate correlations, no variables from the enabling traditional or vulnerable domain were significantly associated with either of the outcome variables. All other factors were represented in each domain.

In Model 1 of Table 4.4, the latent profile of High PSU P4 was significantly associated with increased ER utilization (AOR: 1.90, p<.01). Traditional domain variables were entered in Model 2. High PSU P4 remained significant, and the traditional predisposing factor of gender was significant, such that males were less likely to report ER use (AOR: 0.68; p<.05). In the final Model 3 of Table 4 once vulnerable domain variables were entered, several variables were significant predictors of post-release ER utilization. Individuals categorized by Primarily Heroin P2 PSU patterns emerged as less likely to use the ER (AOR: 0.41, p<.01). Those with High PSU P4 patterns remained more likely to use the ER post-release (AOR: 1.76, p<.05). While gender was significant in Model 2, no traditional domain variables were significant in the final model once vulnerable domains were included. In the vulnerable domain, individuals from rural counties were less likely to utilize ER care (AOR: 0.47, p<.001). Persons with HCV were more than twice as likely to use the ER post-release (AOR: 2.84, p<.001).

Outpatient care utilization is examined in Table 4.5. In Model 1, the Primarily Suboxone P5 group was less likely to utilize outpatient care (AOR: 0.48, p<.05). However once traditional domain variables were entered in Model 9, this association was no longer significant, and in the full Model 10 none of the latent profiles were significant predictors of outpatient care utilization. In the traditional domain, older individuals were more likely to use outpatient care (AOR: 1.03, p<.01). Individuals who were unemployed prior to incarceration (AOR: 0.50, p<.001) and males (AOR: 0.42, p<.001) were less likely to report outpatient visits post-release. In the vulnerable domain, pre-incarceration depression scores were significantly predictive of outpatient visits such that with increasing scores individuals were more likely to report outpatient care (AOR: 1.07, p<.01).

4.4 Discussion

The current study sought to examine pre-incarceration polysubstance opioid use as a predictor of post-release health care using the Behavioral Model for Vulnerable Populations (Gelberg et al., 2000). Multivariate logistic regressions examined latent PSU profiles, traditional, and vulnerable domains as predictive of 12-month post-release utilization of the ER and outpatient visits. PSU patterns significantly predicted ER visits, but not outpatient visits. Overall, this research contributes to the existing literature documenting the vulnerable domain as a robust predictor for justice-involved populations post-release service utilization (Nowotny, 2017; Oser,et al., 2016; Victor, et al., 2018).

It was hypothesized that PSU patterns that were associated with worse physical and mental health symptoms would be more likely to engage with post-release care, particularly ER services. The High PSU profile had significantly worse mental health and more pronounced physical health concerns such as chronic pain. Individuals categorized by this PSU pattern were more likely to use the ER post-release. Prior research has indicated that more diverse PSU patterns are associated with worse physical and mental health (Betts et al., 2016, 2015; Borges, Walters, & Kessler, 2000; Connor, Gullo, White, & Kelly, 2014; Patra, Fischer, Maksimowska, & Rehm, 2009). That these individuals were most likely to use intensive and expensive sources of care may indicate that they lacked regular sources of care, or outpatient care was insufficient at addressing the depth of their comorbidities. Forty-seven percent of individuals in the High PSU P4 group report using outpatient care post-release. However, the current analyses lack the information to garner if individuals first tried outpatient care, were referred to more intensive solutions, or if they simply experienced more crises of care leading them to utilize multiple forms of post-release care.

One profile emerged as less likely to access care. Specifically, the Primarily Heroin P2 group was less likely to access ER care. This is slightly disconcerting considering this profile had

high rates of prior homelessness, IDU, and HCV-- factors associated with increased ER utilization (French, McGeary, Chitwood, & McCoy, 2000; Kerr et al., 2005; Ostertag, Wright, Broadhead, & Altice, 2006). Research has found that despite high need, persons who inject drugs were less likely to receive care on occasions when care was needed (Chitwood, McBride, French, & Comerford, 1999). Persons who inject drugs are less likely to utilize health care for various reasons including insurance status, distrust in physicians/health systems, fear of law enforcement involvement, or lack of desire for treatment (McCoy, Metsch, Chitwood, & Miles, 2001; Neale, 2008; Ostertag et al., 2006; Seal et al., 2001).

None of the PSU profiles emerged as significant predictors of outpatient care. Research has found that persons who use drugs are less likely to utilize outpatient services or seek regular care (Knowlton et al., 2001; Laine et al., 2001). A study of individuals who inject opioids found that persons were less likely to use outpatient services but more likely to use ER services (Chen, Huang, Yeh, & Chien, 2015). Factors beyond substance use alone appear to be more important predictors of outpatient service utilization indicating substance use patterns likely provide more insights into health crises through the use of ER care.

The second aim of the current research was to identify the significant correlates within traditional and vulnerable domains of the Behavioral Model for Vulnerable Populations (Gelberg et al., 2000) as significant predictors of post-release health service utilization. It was expected that vulnerable domains would be robust predictors of utilization, and this was found in the case of ER care, and to a lesser extent for outpatient visits.

To consider ER utilization, vulnerable domain variables of rurality and HCV serostatus were significant correlates. Individuals returning home to rural counties could be less likely to use ER care simply due to availability. Kentucky has 120 counties, several of which have no hospitals or one hospital per county, which may be difficult to access given rural travel and infrastructure barriers (Hare & Barcus, 2007). The current research adds support to findings that previously

justice-involved persons with HCV are more likely to utilize the ER (Humphreys, Ahalt, Stijacic-Cenzer, Widera, & Williams, 2018; Thakarar, Morgan, Gaeta, Hohl, & Drainoni, 2015) indicating that justice-involved persons with HCV have chronic health needs and justice-involvement provides an opportunity for treatment interventions (Rich, Allen, & Williams, 2014).

The vulnerable domain variable of depression was a significant predictor of outpatient visits. This is a hopeful finding, indicating that individuals with increasing severity of depression are linking to care. Often, individuals with increased mental health needs face a variety of negative outcomes post-release while attempting to navigate returning to community life and mental health needs (Binswanger et al., 2012; Hopkin, Evans-Lacko, Forrester, Shaw, & Thornicroft, 2018). Evidence suggests that individuals who are exposed to treatment during incarceration may be more likely to engage in care post-release, including seeking care for different health needs than those for which they previously received treatment (Knowlton et al., 2001). As applied in the current study, individuals' participation in the SAP could have primed them for engagement in treatment for their depression post-release. Individuals may also be more aware of their treatment needs, and research has found individuals with greater perceived mental health treatment need were more likely to be engaged in post-release mental health care (Hamilton & Belenko, 2016). Further, research has indicated that interventions and services aimed at the period of transition from prison to community can improve mental health service utilization post-release (Hopkin et al., 2018). While the current research is only able to report that individuals with increased depression scores were more likely to access s*ome form* of outpatient care, it is worth mentioning the KY DOC social service clinician role in reentry. Post-release, individuals with substance use and mental health histories (i.e., those who participated in SAP), are assigned to a social service clinician in addition to their parole officer. The social service clinicians assist in linking justice-involved individuals to services post-release, to include behavioral health services.

For ER utilization, no traditional domain variables were significant highlighting the need for studies to include both general population factors as well as those unique to vulnerable populations when considering health service utilization. In models predicting outpatient service utilization, the traditional domain factors of age, unemployment, and gender were significant predictors. Extant research exists to support these findings. Longer sentences have led to an aging prison population, with more prodigious health needs and higher rates of chronic conditions (Williams et al., 2010). Older individuals, in general, as well as those with substance and justice histories (Gelberg et al., 2000; Nowotny, 2017; Williams et al., 2013) are more likely to engage in health service utilization post-release.

Following release, men are less likely to access health services (Hamilton & Belenko, 2016; Kouyoumdjian et al., 2018; Oser et al., 2011) and to take longer to access regular care, such as outpatient care (Kouyoumdjian et al., 2018). Finally, individuals who reported unemployment prior to their incarceration were less likely to use outpatient care. This may be a latent indicator of economic hardship, or individuals who lacked employment prior to incarceration may be more likely to have difficulty finding employment post-release. Employment offers financial means to access care as well as potential access to health insurance.

Collectively, the findings highlight the utility of PSU as a unique predictor of health services and indicate the potential for health service interventions during incarceration. PSU patterns were based on pre-incarceration behaviors indicating a captive period of incarceration where individuals could receive interventions and appropriate health services. In the case of certain PSU groups, such as the High PSU P4 profile, this could include confirming that insurance is obtained and linking to regular sources of care since these individuals were more likely to consume more cost-intensive health services. For other groups, such as Primarily Heroin P2 who were less likely to seek health services, interventions could include the opportunity to

meet community health providers during incarceration in order to assist in barriers such as physician mistrust or health service navigation training.

4.4.1 Limitations

The current research has limitations which future research should seek to improve. The sample was from a single southern state, and some of the findings may not translate to other locales. Further, the traditional and vulnerable domains included were limited to those relevant to the current sample as well as by variables included on the baseline assessments. Future research examining service utilization in other states, or preferably multi-state, with population relevant domain variables are necessary. The data are based on self-reports of pre-incarceration behaviors and post-release use of health care. Generally, self-reports are a demonstrated valid source of health service use data (Carroll, Sutherland, Kemp-Casey, & Kinner, 2016) but linkage to health administration data could yield additionally important findings. Finally, the current research only included dichotomous measures of two health-services and future research should examine other health-services (e.g., alternative therapies), number of visits, and the circumstances related to care (e.g., specific health need).

4.4.2 Conclusions

The Behavioral Model for Vulnerable Populations in combination with consideration of PSU opioid patterns revealed important insights into the health service utilization of individuals reentering the community after release from prison and jail. Specific PSU patterns and vulnerable domain variables were efficient predictors of ER care, while traditional and vulnerable domain variables predicted outpatient care. The vulnerabilities associated with justice-involvement and PSU are important to this population's utilization of health services. Implications of the current research indicate that certain PSU populations are at-risk of having their health needs unmet, particularly those who have histories of homelessness and IDU. Further, former justice-involved

populations with high health needs of HCV would benefit from assisted coordination of care to ensure their continuum of care is not disrupted and individuals have access to a regular source of care. The health of justice-involved populations shapes health inequities at the community level (Wildeman & Wang, 2017) and addressing health needs including service utilization of this population will improve public health outcomes at large.

Table 4.1 Fit statistics for latent profile validation analysis

	6,569 Baseline Sample		501 Follow-Up Cohort	
Number of Profiles	AIC	BIC	AIC	BIC
1	409677.5	409786.1	30960.7	31028.2
2	402295.7	402465.5	30073.9	30179.3
3	400521.7	400752.6	29921.7	30065.0
4	400005.1	400297.1	30231.8	30413.1
5	394654.1	395007.2	30127.9	30347.1
6	**393898.7**	**394312.9**	**29810.8**	**30068.0**

Notes: AIC= Akaike's information criterion; BIC= Bayesian Information criterion; bolded indicates selected latent profile

Table 4.2 Latent profile conditional means for polysubstance opioid use (n=501)

	Profile 1	Profile 2	Profile 3	Profile 4	Profile 5	Profile 6
Descriptive profile abbreviation	Primarily Alcohol P1	Primarily Heroin P2	Low PSU P3	High PSU P4	Primarily Suboxone P5	Stimulant -Opioid P6
Latent Profile indicators: Prior 30- day use						
Alcohol	27.66	3.81	2.80	10.27	6.15	8.68
Cocaine	3.08	1.25	0.62	1.97	1.22	28.13
Marijuana	13.95	11.24	11.98	13.68	13.67	14.90
Heroin	1.77	28.85	0.89	7.45	1.94	13.55
Suboxone	1.45	2.71	1.41	9.36	28.49	7.97
Opiates	11.14	15.14	16.51	19.79	13.30	17.21
Amphetamines	6.82	5.77	8.09	9.84	8.37	6.09
Tranquilizers	2.85	4.29	2.77	28.71	4.23	11.11
Profile Prevalence	6.19%	15.97%	42.91%	15.17%	8.58%	11.18%

Note: shading highlights most prevalent substances

Table 4.3 Characteristics of study population (n=501)

	Total Sample	Primarily Alcohol P1	Primarily Heroin P2	Low PSU P3	High PSU P4	Primarily Suboxone P5	Stimulant -Opioid P6	p-value
Traditional Domain								
Age	32.55 (7.67)	33.84 (8.61)	30.54 (6.71)	32.99 (7.70)	33.33 (8.82)	31.81 (6.97)	32.55 (6.91)	.14
Education level	11.87 (2.13)	12.06 (1.65)	11.77 (2.10)	11.83 (2.17)	12.21 (2.53)	11.65 (1.97)	11.78 (1.81)	.70
White	84.83	77.42	90.00	86.05	86.84	83.72	75.00	.17
Unemployed	64.87	70.97	38.75	34.42	35.53	20.93	46.43	.16
Male	72.65	80.65	68.75	72.09	67.11	79.07	78.57	.62
Married	21.36	12.90	22.50	20.93	19.74	30.23	21.43	.45
Economic hardship	2.10 (2.52)	2.42 (2.78)	2.24 (2.75)	1.91 (2.40)	2.25 (2.57)	1.70 (2.11)	2.61 (2.67)	.34
Chronic pain	30.34	32.26	26.25	29.30	44.74	23.26	25.00	.07
Physical health days	7.40 (11.97)	9.42 (13.45)	7.15 (12.12)	6.47 (11.35)	9.25 (12.88)	8.32 (12.03)	6.96 (12.01)	.50
Mental health days	11.54 (13.80)	13.52 (14.15)	12.52 (14.30)	10.12 (13.32)	15.31 (14.21)	9.51 (13.83)	10.91 (13.54)	.07
Vulnerable Domain								
Homeless	20.16	16.13	28.75	14.42	23.68	16.28	30.36	.02
Years incarcerated	2.23 (1.74)	2.60 (2.36)	1.71 (1.25)	2.21 (1.72)	2.61 (1.54)	2.17 (1.46)	2.41 (2.23)	.02
Rural	52.69	58.06	23.75	59.53	56.58	79.07	39.29	.001
Learning disability	25.75	29.03	28.75	21.40	26.32	34.88	28.57	.44
No recovery support	29.74	29.03	30.00	30.23	31.58	25.58	28.57	.99
IDU	61.88	48.39	81.25	50.70	71.05	65.12	69.64	.001
HCV	14.17	9.68	23.75	9.77	18.42	18.60	10.71	.03
Depression	4.44 (3.52)	4.26 (3.55)	5.07 (3.43)	4.01 (3.53)	5.61 (3.31)	3.35 (3.48)	4.55 (3.46)	.002
Anxiety	3.71 (3.23)	3.84 (3.36)	3.51 (3.18)	3.30 (3.22)	4.68 (3.12)	3.74 (3.32)	4.14 (3.15)	.04
Dependent Variables								
Emergency room visits	45.41	29.03	33.75	44.65	60.53	46.51	53.57	.01
Outpatient visits	41.92	45.16	33.75	44.65	47.37	27.91	44.64	.18

Note: p-values obtained through ANOVA and Fisher's exact tests

Table 4.4 Stepwise logistic regression predicting emergency room visits; Adjusted odds ratios (standard errors) reported (n=501)

	Model 1	Model 2	Model 3
Latent Profiles			
Primarily Alcohol P1	0.51 (0.21)	0.53 (0.22)	0.50 (0.22)
Primarily Heroin P2	0.63 (0.17)	0.64 (0.18)	0.41 (0.12)**
High PSU P4	1.90 (0.52)**	1.86 (0.51)*	1.76 (0.50)*
Primarily Suboxone P5	1.08 (0.36)	1.15 (0.39)	1.21 (0.43)
Stimulants-Opioid P6	1.43 (0.43)	1.47 (0.45)	1.28 (0.40)
Traditional domains			
Age		1.01 (0.01)	1.01 (0.01)
Unemployed		0.85 (0.17)	0.87 (0.18)
Male		0.68 (0.14)*	0.69 (0.15)
Chronic pain		1.21 (0.26)	1.18 (0.26)
Mental health days		1.00 (0.01)	0.99 (0.01)
Vulnerable domains			
Rural			0.47 (0.10)***
HCV			2.84 (0.84)***
Depression			1.00 (0.03)
Model X2	16.54**	23.45**	48.83***
Psuedo R2	0.0239	0.0340	0.0707

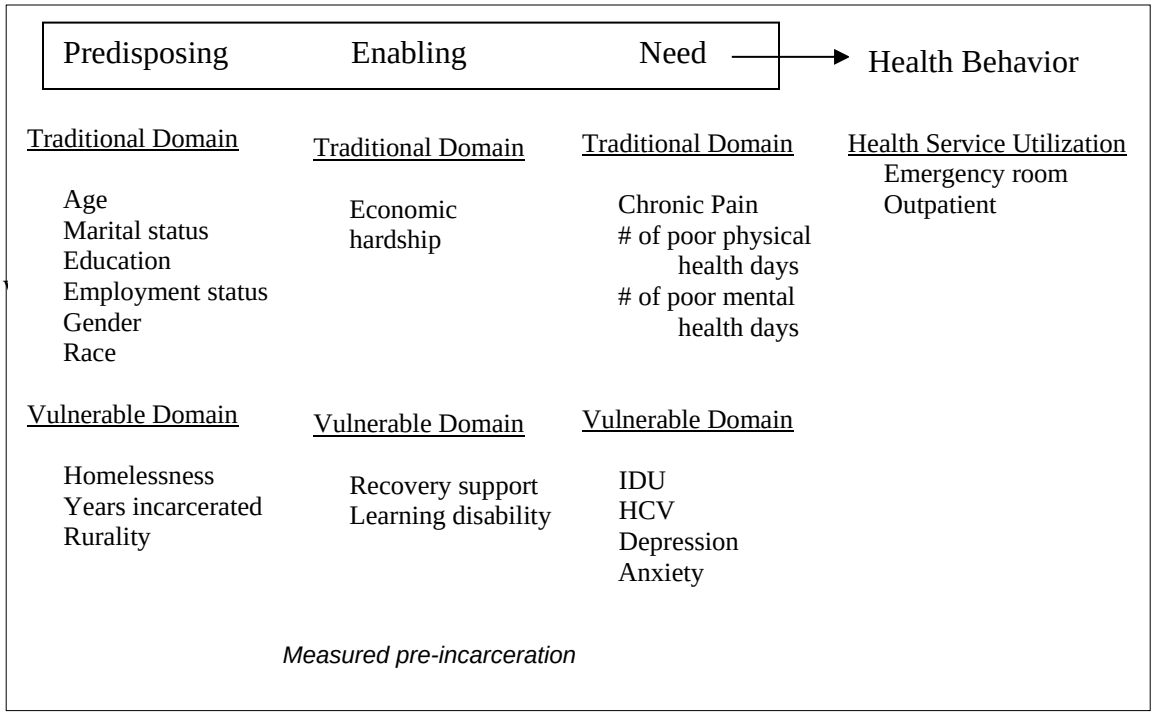
Note: Latent profile 3, low PSU is reference group; significance indicated by *p<.05, **p<.01, ***p<.001

Table 4.5 Stepwise logistic regression predicting outpatient visits; Adjusted odds ratios (standard errors) reported (n=501)

	Model 1	Model 2	Model 3
Latent Profiles			
Primarily Alcohol P1	1.02 (0.39)	1.11 (0.45)	1.10 (0.45)
Primarily Heroin P2	0.63 (0.17)	0.60 (0.17)	0.58 (0.18)
High PSU P4	1.11 (0.30)	1.02 (0.29)	0.96 (0.28)
Primarily Suboxone P5	0.48 (0.17)*	0.56 (0.21)	0.56 (0.21)
Stimulants-Opioid P6	1.00 (0.30)	0.99 (0.31)	0.98 (0.31)
Traditional domains			
Age		1.03 (0.01)*	1.03 (0.01)*
Unemployed		0.49 (0.10)***	0.50 (0.10)***
Male		0.39 (0.09)***	0.42 (0.09)***
Chronic pain		1.13 (0.25)	1.09 (0.24)
Mental health days		1.00 (0.01)	1.00 (0.01)
Vulnerable domains			
Rural			1.11 (0.23)
HCV			0.99 (0.29)
Depression			1.07 (0.03)*
Model X2	7.76	55.40***	60.10***
Psuedo R2	0.0114	0.0813	0.0882

Note: Latent profile 3, low PSU is reference group; significance indicated by *p<.05, **p<.01, ***p<.001

Figure 4-1Behavioral Model for Vulnerable Populations (Gelberg, Andersen, & Leake, 2000) as applied in current research



CHAPTER 5. CONCLUSION

The current research explored the topic of polysubstance opioid use among a justice-involved sample, to include the effect of polysubstance use (PSU) on subsequent reentry outcomes of relapse and health service utilization. Chapter 2 determined the polysubstance opioid patterns that were prevalent among a recently incarcerated population through the use of latent profile analysis. Chapter 3 examined how post-release relapse was affected by pre-incarceration polysubstance use patterns, and was guided by the Behavioral Model for Vulnerable Populations (Gelberg, Andersen, & Leake, 2000). Chapter 4 explored latent profiles along with the vulnerable and traditional domains of the Behavioral Model for Vulnerable Populations as predictors of emergency room and outpatient visits in the 12-months post-release.

The research presented here makes four significant contributions to the literature. First, the research is among the first known to examine polysubstance opioid use patterns among a justice-involved population. Secondly, the use of 30-day continuous indicators in latent profile analysis as opposed to latent class analysis provides a unique methodological contribution and yielded more detailed information about PSU patterns. Third, the results indicate a continuum of risk according to PSU patterns which differentially affect reentry processes among an already vulnerable population. Finally, through the use of the Behavioral Model for Vulnerable Populations, the current research further adds to literature advocating for the consideration of vulnerable population specific factors when examining health services as well as expanding use of the model to the health outcome of relapse.

5.1 Key Findings

5.1.1 Heterogeneity of Substance Use among a Justice-Involved Sample

The current research found distinct profiles of PSU among a justice-involved sample with recent history of opioid use. While previous research had indicated that more severe drug use and

PSU was likely among justice populations (Betts et al., 2016; Green, Black, Serrano, Budman, & Butler, 2011; Kubiak, 2004; Lo & Stephens, 2000), it was unclear to what extent pre-incarceration PSU patterns of justice populations were similar or differed from general populations. Chapter 2 revealed six distinct profiles of PSU opioid use in the current sample. These profiles replicated in a second sample in Chapters 3 & 4 as well. While the PSU patterns may be unique to Kentucky's justice-involved population, the findings revealed that compared to general populations, PSU among justice-involved populations is more severe. For example, the Low-Use profile- those with the least amount of PSU- reported an average of 14 days of opiate use, while general population research of individuals who misuse opiates cite an average of 7 days of prior 30 (NSDUH, 2017).

It was expected that PSU justice populations would have additionally severe physical and mental health comorbidities, given already high prevalence rates of justice populations and research indicating PSU populations have a high comorbidity as well (Borges, Walters, & Kessler, 2000; Connor, Gullo, White, & Kelly, 2014; Feaster et al., 2016; Mallik-Kane & Visher, 2008; Quek et al., 2013; Wu et al., 2011). This hypothesis was largely supported, as the profiles with the most diverse (e.g., more substances) patterns of substance use were more likely to have poor physical health, depression, and anxiety (Chapter 2). Collectively, the diverse profiles of High PSU and Stimulant-Opioid accounted for nearly 30% of the total sample- indicating that among justice-involved populations high-risk PSU with health comorbidities may be more common than in general populations.

5.1.2 Methodological Innovations

The current research was among the first to utilize continuous indicators in creation of latent profiles in order to provide more nuanced insights to the phenomena of PSU. As detailed in the systematic review of Chapter 1, the majority of studies of PSU among persons who use opioids rely on dichotomous indicators and latent class analysis. The current research limited the

samples to individuals who reported using more than one substance on a given day- thus including individuals with inclinations toward PSU by design. Further, the use of continuous 30-day indicators revealed greater details to PSU patterns than dichotomous indicators alone. For example, in Chapter 2 findings from LPA reported that the Stimulant-Opioid P6 had an average of 10 days of alcohol use, 27 days cocaine use, 18 days marijuana use, 15 days heroin use, 9 days illicit Suboxone use, 18 days opiate use, 11 days amphetamines use, and 11 days of tranquilizers use. With this information it is apparent that 10-25 days of the month individuals in this profile are co-using one or more substances. If these had been measured dichotomously through yes/no use in the previous month, the risk behavior of the Stimulant-Opioid P6 group would have been underestimated and not fully understood. The use of continuous indicators in future research is imperative to advancing more detailed understandings of PSU.

5.1.3 Continuum of Risk of PSU

The collective findings indicated a continuum of risk to exist among PSU. In Chapter 2, risk was inherent to the profiles. That is, the profiles varied from a Low-Use (little PSU) to high-risk PSU profiles (i.e., High PSU) where co-use of known overdose combinations (e.g., tranquilizers and opiates) was occurring more than 2/3 of the month. Chapter 3 explored the relationship between PSU and post-release relapse. For post-release relapse, risk was highest among individuals with Primarily Alcohol and Primarily Suboxone PSU patterns. Finally, in Chapter 4, heterogeneity of risk was found among individuals post-release health service utilization such that certain profiles were less likely to access care (i.e., Primarily Heroin) while others were more likely (i.e., High PSU).

When considered together, the findings indicate that risk of adverse outcomes differ by PSU patterns. These findings add to literature suggesting that recovery pathways differ by substances (Castro, Barrington, Walton, & Rawson, 2000; Hser, 2007), and would go further by suggesting that pathways differ by *preferred combinations* of substances. The findings in Chapter

4 suggest that understanding pre-incarceration substance use patterns can assist in understanding the type of post-release care individuals are likely to need. In Chapter 2, it was found that individuals were more likely to engage in High PSU patterns if they had low levels of education, more days of poor physical health, higher anxiety symptoms, and histories of injection drug use. In Chapter 4, this profile was revealed to be most likely to use emergency room care, which has significant financial ramifications. Collectively, the findings indicate that while all PSU carries inherent risk there is a continuum of risk by which PSU patterns can be considered.

5.1.4 Importance of Vulnerability

The use of the Behavioral Model for Vulnerable Populations in Chapter 4 indicated the continued importance of considering variables unique to vulnerable populations when examining health service utilization. In the model predicting emergency room care, the latent profiles and vulnerable domain variables were significant predictors of utilization. For outpatient visits, the vulnerable domain variable of HCV was a significant predictor. The importance of vulnerable domain variables is further evident in the Chapter 4 block models examining emergency room utilization, such that once vulnerable variables were entered in the complete model, the traditional variables were no longer significant. Failure to account for vulnerable population specific variables could improperly attribute predictors of service utilization.

Further, the current research expanded the use of the Behavioral Model for Vulnerable Populations to post-release health behaviors by examining post-release relapse. Only one other study utilized the conceptual model to predict post-release relapse, and that research did not stratify variables according to traditional or vulnerable domains (Krishnan et al., 2013). In addition to latent profiles, both traditional and vulnerable domain variables were significant predictors of post-release relapse further highlighting the importance of modeling these domains as specific to the populations they consider.

5.2 Implications and Real-World Considerations

The current research yielded several implications for policy and practice. These ideas have been developed in Chapters 2-4, with specific details regarding possible interventions for each PSU profile detailed in Chapter 2. However, it is important to again highlight the overarching idea that PSU screening is an important tool that can be used to funnel individuals to appropriate interventions. This is particularly relevant for justice-involved individuals who face periods of population isolation during incarceration, and criminal justice venues provide an important opportunity for intervention with at-risk populations.

Substance use treatment programs within prisons and jails that provide baseline assessments, such as the KY SAP detailed in this dissertation, could create profile identification tools. For example, with sufficient replication in future justice populations, individuals who meet the criteria for certain PSU profiles based on responses to baseline assessment questions would be 'flagged' so that they could be funneled into appropriate interventions. While replication of the current study (Chapter 2) is necessary to determine if justice-involved PSU patterns replicate on a local or national level, there are certain patterns which at this point are known to exist in multiple populations- the High PSU and Stimulant-Opioid profiles (see details in Chapter 2) based on these findings and existing research (Harrell, Mancha, Petras, Trenz, & Latimer, 2012; Kuramoto, Bohnert, & Latkin, 2011; Meacham et al., 2016; Roy, Richer, Arruda, Vandermeerschen, & Bruneau, 2013). Determining appropriate interventions for these profiles would provide a good starting point for PSU intervention development.

Further, the current research has demonstrated efficacy of measuring and considering PSU as an important factor of post-release behavior. PSU profiles were significant predictors of post-release relapse and ER utilization. That PSU behaviors offer understanding to post-release behaviors is a novel contribution. In conjunction with the ideas above, these findings indicate that

interventions can be tailored both pre-release and continue into the community in order to improve outcomes for justice-involved populations.

Finally, the research findings here support the idea that as a discipline there is a need to expand conceptualizations of substance use beyond the ideals of primary substance. This includes understandings of recovery, where researchers have been advocating for more dynamic measurements of relapse (White & Ali, 2010; White, 2007). In order positively influence the lives of individuals with substance use disorders, and in turn community health as a whole, researchers should go beyond siloing individuals according to their primary substance. Given that individuals often seek out PSU due to preferred effects, research stands to create more impactful change by understanding these motivations and adjusting interventions and suggestions for policy appropriately.

5.3 Future Directions for Research

While specific directions for future research are mentioned in each of the chapters, there are three broad suggestions to consider which have been mentioned but are succinctly stated here. First, there is significant heterogeneity among opioid PSU in a justice-involved population. PSU patterns are more severe and differ from previous general population research. Future research is needed to determine if the profiles observed here replicate, or if they are unique to KY's justice-involved population.

Secondly, there is a continuum of risk among opioid PSU populations. That is, not all profiles were at risk of adverse outcomes post-release. Tailoring interventions for at-risk profiles during the period of justice-involvement and making appropriate linkages to care would assist in mitigating adverse post-release outcomes.

Finally, through the process of the dissertation research it became apparent that there are significant lapses in our current understandings of PSU, in part due to the limitations of existing

instrumentation. Development of appropriate screening and assessment tools that can (1) measure different types of PSU (e.g., simultaneous, regular interval), (2) provide details as to PSU patterns including method of administration (e.g., injection, intranasal), and (3) in more real-time circumstances (as opposed to call-back of long-periods of time) are greatly needed.

5.4 Conclusion

In the current opioid epidemic, overall life expectancy in the United States is falling owing to increased drug overdose deaths (Larney & Hall, 2019). It is critical to recognize the role PSU has in the current epidemic, as well as identification of individuals who are most likely to be impacted. Individuals with justice-involvement are at pronounced risk of overdose death following release (Binswanger, Blatchford, Mueller, & Stern, 2013). The research above has made clear that PSU is pronounced among justice-involved populations with histories of opioid use, placing them at great risk of adverse outcomes. Identifying at-risk PSU patterns among justice-involved populations in order to design effective interventions is critically important. Moreover, improving the health of justice-involved populations is crucial for better population health nationwide.

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VITA

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Education

2014 M.A. Applied Sociology, University of Maryland Baltimore County, Baltimore, MD

2013 Graduate Certificate in the Non-Profit Sector, University of Maryland Baltimore County, Baltimore, MD

2011 Graduate Certificate of Thanatology, Hood College, Frederick, MD

2009 B.A. Sociology, Hood College, Frederick, MD

Awards, Honors and Fellowships

2018 Clifford C. Clogg Scholarship, ICPSR Summer Program in Quantitative Methods of Social Research

John A. O'Donnell Award for Most Outstanding Graduate Student, Department of Sociology, University of Kentucky.

P.E.O. (Philanthropic Educational Organization) Scholar Award ($15,000, awarded to 100 women of 741 nominees)

Student Scholarship, Academic Consortium on Criminal Justice Health, Academic & Health Policy Conference on Correctional Health Scholarship

University of Kentucky Association of Emeriti Faculty Endowed Faculty Fellowship Award ($2,500, awarded to three students annually)

2017 Pre-doctoral Traineeship, Department of Behavioral Science, University of Kentucky, funded by the National Institute on Drug Abuse (T32-DA035200, "Research Training in Drug Abuse Behavior," PI: Craig Rush) (awarded for two years)

2016 Presidential Graduate Fellowship ($20,000)

2015 Howard Beers Summer Fellowship ($1,000)

2014 Sociology Honors Society Induction, Alpha Kappa Delta

2012 Delegate Scholarship (two-year award)

Maryland Senatorial Scholarship (two-year award)

2008 Spanish Honor Society Induction, Sigma Delta Pi

2005 Presidential Scholarship, Hood College (four-year award)

Publications

Smith, Kirsten E., **Amanda M. Bunting**, Seana Golder, Martin T. Hall, George Higgins, and TK Logan. 2019. "Prevalence and Correlates of Disability Among a Sample of Women with

a History of Victimization on Probation and Parole." Forthcoming in *Journal of Correctional Health Care.*

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Oser, Carrie B., **Amanda M. Bunting**, Erin Pullen, and Danelle Stevens-Watkins. 2016. "African American Female Offender's Use of Alternative and Traditional Health Services After Re-Entry: Examining the Behavioral Model for Vulnerable Populations." *Journal of Health Care for the Poor and Underserved* 27(2):120-148.

Bunting, Amanda M. 2012. "A Sociological Study of Graffiti in Seville, Spain." *Journal of Student Research* 1(2): 51-54.

Bunting, Amanda M. and Janet Stamatel. "Exploring Geospatial Characteristics of Hashtag Activism in Ferguson, Missouri: An Application of Social Disorganization Theory." (R&R).

Harp, Kathi L.H. and **Amanda M. Bunting**. "The Racialized Nature of Child Welfare Policies and the Social Control of Black Bodies." (R&R).

Staton, Michele, **Amanda M. Bunting**, and Erika Pike. "A Latent Class Analysis of Rural Women Who Use Drugs and Commit Crimes." (Under Review).

Research Experience

2016 Research Assistant, University of Kentucky, Lexington, KY.

Principal Investigator: Dr. Kristen Mark
Project: Mixed Sex Couples Study funded by the American Institute of Bisexuality

2015 Research Assistant, University of Kentucky, Lexington, KY.
Principal Investigator: Dr. Courtney Thomas

2015 Graduate Researcher, University of Kentucky, Lexington, KY.
Faculty Advisor: Dr. Janet Stamatel
Project: Geospatial analysis of Twitter activism surrounding the shooting of Michael Brown

2015 Research Assistant, University of Kentucky, Lexington, KY.
Principal Investigators: Dr. Claire Renzetti and Marissa Castellanos
Project: Evaluation of Liberation Louisville Initiative, Catholic Charities Human Trafficking Program

2015 Research Assistant, University of Kentucky, Lexington, KY.
Principal Investigator: Dr. Kristen Mark
Project: Male Sexual Functioning Study

2014 Research Assistant, University of Kentucky, Lexington, KY.
Principal Investigator: Dr. Carrie Oser
Project: Black Women in the Study of Epidemics (B-WISE) funded by NIDA R01-DA022967

2012-2013 Research Associate, Office of Oral Health, Maryland Department of Health and Mental Hygiene, Baltimore, MD.
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