THESIS

POLYSUBSTANCE USE PROTECTIVE STRATEGIES FOR CONCERT AND FESTIVAL CONTEXTS: INVENTORY DEVELOPMENT AND CHARACTERIZATION OF PERSONAL DRUG CHECKING PRACTICES

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ABSTRACT

POLYSUBSTANCE USE PROTECTIVE STRATEGIES FOR CONCERT AND FESTIVAL CONTEXTS: INVENTORY DEVELOPMENT AND CHARACTERIZATION OF PERSONAL DRUG CHECKING PRACTICES

Polysubstance use is prevalent at electronic dance music (EDM) events and attendees are at elevated risk of experiencing adverse substance-related outcomes. Protective behavioral strategies (PBS) implemented at the individual level (e.g., test drugs for presence of fentanyl) may help to mitigate substance-related consequences such as accidental overdose. While there is considerable evidence demonstrating the efficacy of PBS for alcohol and cannabis use, little research has examined PBS for other substances and there are currently no validated measures of polysubstance use PBS.

Participants (aged 18-65) were two community samples of EDM event attendees in Colorado. Both studies used field methods to survey event attendees on their substance use and PBS use patterns. Study 1 (*N*=450) was conducted in two phases with the goal of developing and establishing initial content and criterion validity for an inventory of polysubstance use PBS. Study 2 (*N*=227) involved a deeper exploration of drug checking PBS (i.e., use of reagent test kits and fentanyl test strips) and polysubstance use patterns among attendees of a 4-day music festival.

Study 1 results indicate that EDM event attendees employ a variety of PBS to protect themselves while engaging in polysubstance use at concerts and festivals. Polysubstance use PBS include strategies related to collective community welfare (e.g., “When attending an event

with friends, I make sure to let others in the group know what drugs I am taking"), dosing practices (e.g., "If I am mixing drugs, the quantity I take of each drug is lower than if I take them separately"), mindfulness and body awareness (e.g., "I check in with myself while using drugs to see how I am feeling"), environmental safety (e.g., "Before using drugs at an event, I familiarize myself with the location of medical stations and/or harm reduction services"), and minimizing risks associated with an unregulated illicit drug supply (e.g., "I analyze my drugs with fentanyl test strips when applicable"). Polysubstance use PBS (i.e., mean frequency of use and mean perceived effectiveness) were negatively associated with past-year consequences (i.e., mean frequency and total number of consequences).

Study 2 results indicate that participants engaged in differential patterns of polysubstance use that varied significantly by festival event day, with participants using a greater mean number of substances on days 2 and 3 of the festival. The percentage of participants having ever used reagent test kits and FTS was 75.3% and 66.5% respectively. When asked how often participants ensure their drugs are tested prior to consumption, participants responding "always" or "most of the time" was 54.4% for use of reagent test kits and 59.4% for use of FTS. 60.8% of participants reported that they had never consumed a drug that reagent tested differently than expected and 87.9% of participants reported that they had never consumed a drug that tested positive for fentanyl.

Engagement with polysubstance use PBS appears to help individuals attending EDM events to reduce substance-related harms. Given that perceived effectiveness of PBS was also linked to reduced harm, interventions aimed at increasing beliefs related to PBS efficacy may be useful. Reagent test kits and fentanyl test strips seem to empower festival attendees to make informed decisions related to their substance use and health. Thus, there is a critical need to

continue expanding access to drug checking tools, training, and services for this at-risk population.

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TABLE OF CONTENTS

INTRODUCTION

Approximately 50% of Americans attend concerts each year and 18% attend music festivals (Nielsen, 2015). In particular, the popularity of electronic dance music (EDM) events has increased dramatically over the past decade (Watson, 2018). While the COVID-19 pandemic resulted in the cancellation of many concerts and festivals during 2020 and early 2021, most music events have returned following decreased COVID-19 event restrictions and widespread vaccine availability. For example, Electric Daisy Carnival Las Vegas (a popular EDM event in the U.S.) recently hosted over 450,000 attendees at their annual event (McFarland, 2021). Substance use is prevalent at EDM events and attendees are at elevated risk of experiencing adverse substance-related outcomes (Palamar et al., 2019). Given current record high rates of overdose in the U.S. (Ahmad et al., 2021), there is an urgent need to investigate pathways towards safer substance use among this at-risk population.

Characterizing and Contextualizing the EDM Event Experience

Classification of Event-Types

Redfield and Thouin-Savard (2017) identified four distinct types of EDM events: raves, after-hours clubs, music festivals, and mainstream clubs/concerts. Historically, the term rave refers to an underground, unlicensed EDM event, often occurring spontaneously within an obscure location (e.g., beach, forest, warehouse). However, in the 1990s and early 2000s, elements of the rave experience became commercialized, and these once underground parties soon expanded into licensed, organized events. While underground raves still occur today, organized, licensed events (e.g., concerts and festivals) have become the norm.

After-hours clubs are licensed events that stay open later than state curfews for clubs that serve alcohol, and have been described as a hybrid between underground raves and organized EDM events. EDM festivals are large-scale gatherings transpiring over the course of several days, while EDM concerts are typically one day and tend to elicit smaller crowds. Additionally, EDM festivals feature a variety of acts across the continuum of EDM subgenres, whereas EDM concerts feature a smaller number of acts, usually within the same or similar subgenres.

Regardless of event-type, elaborate visual effects are nearly ubiquitous at EDM events and may include lasers, strobe lights, projection mapping, and VJing (i.e., live manipulation of digital imagery in synchronization with music). Performance art, film, and live painting are also common, but overall, the types of visual effects present at any given event vary depending on the budget and overarching vision of the organizers (Redfield & Thouin-Savard, 2017). The elaborate visual effects present at EDM events may inspire attendees to use certain drugs (e.g., psychedelics) as a way to enhance the experience.

Transpersonal Exploration.

For many attendees, the EDM event experience can also be characterized by transpersonal exploration. As defined by Walsh et al. (1993, p. 203), transpersonal experiences refer to instances in which “the sense of identity or self extends beyond (trans) the individual or personal to encompass wider aspects of humankind, life, psyche or cosmos" (Walsh et al., 1993, p. 203). Highlighting transpersonal exploration within the EDM scene, Redfield (2017) conducted semi-structured interviews with 12 individuals on their experiences of transpersonal phenomena while attending EDM events. Thematic analyses revealed that EDM events are capable of producing powerful intrapersonal and spiritual experiences. While factors such as event environment, dancing, and music were identified as key in eliciting transpersonal

phenomena, drug use was also cited by two thirds of participants as a facilitating mechanism. For example, one participant reported experiencing transpersonal phenomena while attending EDM events under the influence of LSD:

> I mostly kept going to psychedelic trance parties and my friends kind of came along once in a while. I would even go by myself. . . I became really moved by it, just the trance music. It was a way to travel to places and reach my own familial patterns and like family systems and things as well as transpersonal and visionary states and relationships and meeting people and being confident as a person and growing at the same time and stepping into different roles and becoming a leader, all within the community framework (Redfield, 2017, p. 72).

Indeed, a large body of evidence suggests that experimentation with substances such as MDMA, cocaine, speed, ketamine, psychedelics, and novel psychoactive substances are frequently reported among EDM event attendees (Fox et al., 2018; Hughes et al., 2017; Palamar et al., 2016; Palamar et al., 2017; Redfield, 2017). Due to the powerful audio-visual-sensory experiences curated by EDM event organizers and the culture of consciousness transformation present within the EDM community, EDM events may present an idyllic environment to engage in drug use.

Substance-related Risks at EDM Events

While EDM events may facilitate intrapersonal transformation, it is critical to note that attendees are at elevated risk of experiencing adverse substance-related medical outcomes (Hutton et al., 2014). For example, a recent epidemiological study of EDM parties in New York City found that increased involvement in the EDM scene is associated with greater risk of experiencing negative drug-related effects and that 33.5% of EDM event attendees had

experienced a harmful drug-related consequence in the past year (Palamar et al., 2019). Evidence also suggests that initiation of substance use at EDM events is common. Palamar (2020) conducted a survey of 1,020 individuals who regularly attend EDM events and found that among attendees endorsing past year ecstasy use, 42.9% reported that their first use of ecstasy was unplanned. Moreover, a staggering 33.4% of participants endorsed using for the first time at an EDM festival and 24.3% endorsed using for the first time at a nightclub. This is particularly troubling given that lack of experience with party drugs and lack of experience within the EDM scene have been identified as risk factors for experiencing substance-related consequences at EDM events (Palamar & Sönmez, 2022).

Synthetic Opioids and the Overdose Crisis

The U.S is currently facing an overdose crisis, with The Centers for Disease Control and Prevention (CDC) reporting over 100,000 overdose deaths between April 2020 and 2021 (Ahmad et al., 2021). An increased presence of synthetic opioids in the illicit drug supply has contributed to this crisis (D'Errico, 2018; Salle et al., 2019), along with prohibitionist policies that largely prevent quality control of drugs. Synthetic opioids were involved in approximately 64% of the fatal overdoses documented in 2021, and there were more synthetic opioid overdose deaths in 2021 than deaths from all classes of drugs combined in 2016 (Ahmad et al., 2021).

Synthetic opioids are potent μ-opioid receptor agonists, which mimic the effects of natural opioids such as heroin and opium (Salle et al., 2019). These include drugs such as fentanyl, fentanyl analogues, (e.g., acetylfentanyl, ocfentanil, carfentanil, furanylfentanyl, fluorofentanyl) and non-fentanyl analogs (e.g., U-47000, AH-7921, MT-45). However, due to stringent drug control laws in the U.S., new synthetic opioids (NSOs) are constantly emerging as a means for illicit drug manufacturers to circumvent federal drug restrictions.

As full opioid agonists, synthetic opioids are remarkably potent (e.g., fentanyl is approximately 50 to 100 times more potent than morphine and carfentanil is approximately 10,000 times more potent; D'Errico, 2018). In the case of carfentanil, intoxication may be achieved at doses as low as one microgram (National Center for Biotechnology Information, 2022). The strong potency of synthetic opioids greatly increases risk of fatal overdose, particularly when people who use drugs (PWUD) are unaware of its presence in their drug sample. In recent years, synthetic opioids have become an adulterant in natural opioids such as heroin, as well as other non-opioid illicit drugs (e.g., cocaine).

Drug Adulteration and Contamination

Drug adulterants are pharmacologically active ingredients intentionally added to substances to produce antagonistic or synergistic effects (Solimini et al., 2017). Illicit drugs are often adulterated as a means for manufacturers to boost profit margins by increasing bulk, enhancing a pharmacological effect, or facilitating drug delivery (Cole et al., 2011). In recent years, synthetic opioids have become an adulterant in other illicit drugs due to their low cost, ease of synthesis, and powerful intoxicating effects. (Larabi et al., 2020; Evans-Brown et al., 2018). While synthetic opioid adulteration is most common in natural opioids such as heroin, drug checking services (e.g., DanceSafe) and post-mortem toxicology reports have also detected fentanyl in drugs such as cocaine, MDMA, and ketamine which are frequently used by individuals attending EDM events (DiSalvo et al., 2021; Willey, 2021). Critically however, unintentional contamination of drugs with fentanyl is also possible and according to anecdotal evidence, may be a more likely cause of party drugs containing fentanyl. Specifically, contamination refers to accidental mixing of substances during production and distribution

processes (e.g., when the same equipment or surfaces are used for multiple drugs without sanitation).

Due to grassroots drug education initiatives and wide-spread media coverage of the overdose crisis in recent years, many individuals within the EDM community are now aware of concerns related to synthetic opioid adulteration and contamination. In a study comparing EDM event attendees' perceptions of party drug adulteration in 2018 and 2019, Palamar et al. (2021) found that prevalence of understanding cocaine may contain fentanyl increased significantly (42.1% to 58.6%), but found no significant increase in understanding that MDMA may contain adulterants (55.0% to 59.0%), or that non-pharmacy prescription drugs may contain fentanyl (46.8% to 52.9%). However, among participants who specifically endorsed past year MDMA use, there was a significant increase in understanding that MDMA may contain adulterants (52.9% to 80.0%) and among those endorsing past-year cocaine use, there was a significant increase in understanding that cocaine may contain adulterants (48.2% to 70.7%). While knowledge that party drugs may contain adulterants has increased in recent years among EDM event attendees, the authors estimated that around half of individuals within the EDM community still lack awareness concerning this issue.

In addition to drug adulteration, PWUD also run the risk that any drug purchased from the illicit market is an entirely different substance altogether than what they intended to consume. For example, it is not uncommon for methamphetamine ("meth") or speed/amphetamine to be marketed and sold as MDMA. Palamar & Barratt (2019) surveyed individuals entering EDM parties in New York City in 2017 about their reagent test kit use and perceptions of MDMA purity. Results indicated that following reagent testing, 51.1% of MDMA users "found out" or suspected that their MDMA sample contained a drug other than MDMA,

with 49.2% of participants reporting that their MDMA contained methamphetamine or speed/amphetamine. Such conditions may render PWUD unable to properly dose their substance, thereby increasing risk of accidental overdose or other adverse drug-related effects.

Polysubstance Use

Polysubstance use involves using more than one substance at the same time (i.e., simultaneous use) or on separate occasions (i.e., concurrent use; Crummy et al., 2020). Both patterns of polysubstance use are prevalent at EDM events (Fernández-Calderón et al., 2011; Palamar & Keyes, 2020; Sañudo et al., 2015). For example, one survey of EDM event attendees indicated that participants had used a mean of 4.9 different drugs at the last event they attended, with over 75% of participants reporting use of tobacco, alcohol, cannabis, and amphetamine, and over half reporting use of powder MDMA (Fernández-Calderón et al., 2011). Further, a qualitative study by Hunt et al. (2009) found that 92% of participants had engaged in concurrent use of two or more substances in the past year, with the most commonly co-used substances reported as follows: cannabis and ecstasy (59%), cannabis and alcohol (45%), ecstasy and alcohol (28%), ecstasy and acid (28%), and ecstasy and tobacco (28%).

Polysubstance Use Motives

Another key takeaway from Hunt et al. (2009) is that individuals within the EDM scene have varying motives for engaging in polysubstance use. Motives include seeking out a particular effect, modifying or enhancing the effects of another drug, extending the effects of a drug already consumed, and reducing negative or unwanted effects of a drug. Experimentation was also highlighted as a key aspect of the polysubstance use experience for many attendees. For example, one participant stated the following about her experience of exploring various drug combinations:

> Well, back then when I used it [GHB] frequently... we were all about getting as high as we possibly could...We'd mix like speed with GHB. We did a lot of drugs mixing. We figured out which drugs were the best to use with which, which ones cancelled out... you know, certain drugs' effects, and stuff like that. We found that doing speed and doing ecstasy was a great combo. Or doing GHB and doing speed was a great combo.

Overall, researchers concluded that polysubstance use was a "trial and error" process for many attendees and noted that favored drug combinations varied widely between participants.

Polysubstance Use Risks

It is well-documented that polysubstance use is associated with experiencing a greater number of adverse outcomes than single substance use, with simultaneous use presenting the greatest concern (e.g., Baggio et al., 2014; Morley et al., 2015). Notably, epidemiological evidence suggests that among EDM event attendees reporting an adverse substance-related outcome in the past year, polysubstance use was implicated in over a fifth of cases (Palamar, Acosta, Le, et al., 2019). Results also indicated that consuming alcohol alongside other substances was particularly risky, with two-thirds (67.8%) of participants reporting that alcohol was involved in their adverse event. Further evidencing the dangerous effects of alcohol consumption in combination with other drugs, Vera et al. (2021) conducted a latent class analysis of EDM event attendees to identify profiles of simultaneous polysubstance use. Two classes emerged from this analysis: moderate simultaneous polysubstance use and severe simultaneous polysubstance use. However, results indicated that regardless of user profile, avoiding binge drinking was associated with experiencing fewer adverse outcomes.

While all polysubstance use is risky, the simultaneous use of alcohol and opiates have been consistently recognized as one of the deadliest combinations due to their synergistic

depressant effects. Epidemiological evidence suggests that among opiate fatalities involving more than one drug, alcohol is the most common drug involved (Hickman et al., 2008). Moreover, in a dose-escalating co-administration study of oral oxycodone and intravenous ethanol, consuming a single 20 g tablet of oxycodone alongside a modest dose of alcohol significantly increased risk of respiratory depression (van der Schrier et al., 2017). Within the context of EDM events, these findings are particularly troubling given the prevalence of alcohol consumption at events and the recent increased synthetic opioid adulteration/contamination of drugs commonly used by EDM event attendees.

Temporal Patterns and Phases of Polysubstance Use

To fully understand polysubstance use risks within the EDM scene, it is important to consider earlier research suggesting that individuals may use a variety of drugs for various purposes throughout the duration of an event. Boys et al. (1997) identified three stages that occur for EDM event attendees during a night out: 1) social experiences prior to an event 2) experiences at the event itself and 3) the "come down" period following an event. Critically, these phases were found to be associated with differential patterns of substance use. Cannabis and amphetamines were most commonly used prior to events, ecstasy was most commonly used while at events, and cannabis was most commonly used following events. However, Forsyth (1996) also found that many attendees reported using depressants such as temazepam during the come down period instead of cannabis.

Building on these earlier findings, Hunt et al. (2009) pinpointed two distinct temporal patterns of polysubstance use: 1) polysubstance use that is structured around an event and 2) unplanned polysubstance use that is dependent on an individual's level of intoxication. In the first pattern, individuals time their use around an event, in a controlled and carefully planned

manner. However, in this second pattern, individuals base their polysubstance use around how they feel in the moment and make decisions based on achieving a desired effect. To illustrate, in pattern one, an individual might strategically plan to consume MDMA at the beginning of an event, use ketamine two hours later, and finish the night with cannabis. An example of pattern two might involve consuming a tab of LSD and deciding to consume MDMA only once the individual begins to feel the "peak" of the LSD experience.

Environment-specific Risks

In addition to hazards associated with drug adulteration and polysubstance use, EDM events confer unique environment-specific risks. Attendees are often packed into hot, crowded, and poorly ventilated spaces, which may increase risk of medical emergencies such as heat exhaustion or hyperthermia. For example, Bohnert et al., (2010) found a strong positive relationship between ambient temperature and accidental cocaine overdose mortality. Likewise, in a case study of 12 patients hospitalized with MDMA toxicity during a single EDM event, the event's warm ambient environment was identified as a factor contributing to the severity of patient presentation (Armenian et al., 2013). Physical exertion was also identified as a potential antecedent to hyperthermia, as EDM event attendees often dance for hours on end with few breaks in between. EDM festivals likely present the highest risk, given that they occur over the course of several days, with many festivals open for roughly 12 hours per day (e.g., noon to midnight).

In a recent qualitative study, Palamar & Sönmez (2022) conducted in-depth interviews with 35 individuals involved in the EDM scene who considered themselves to be experts in novel psychoactive substances, and who were classified as a cohort of experienced drug users, drug screeners, or drug sellers. The aim of the study was to examine factors specific to the EDM

festival environment that increase incidence of adverse drug-related outcomes. The four common themes that emerged were 1) inexperienced attendees 2) risky drug purchases 3) risky drug practices and 4) environment-specific risk factors. Again, a key environmental risk factor identified by participants was dense crowded dancefloors, which interviewees noted have the potential increase overheating and dehydration, elevate anxiety, and create challenges in terms of seeking food, water, and medical assistance. Further, participants stated that overheating and dehydration are of particular risk due to many festivals occurring outside during summer months. Long consecutive days of dancing place additional strain on the body, especially when drugs are consumed. Lastly, access to high quality medical care is often limited at EDM events and the presence of police officers/event security at festival medical tents were reported as a barrier to some individuals seeking out medical attention.

Harm Reduction

Harm reduction is a framework for understanding substance use that extends beyond abstinence-only approaches to risk mitigation (Marlatt et al., 2011). Instead, harm reduction emphasizes compassionate and pragmatic pathways towards safer substance use at both the individual (e.g., avoid mixing depressants) and community level (e.g., needle exchange programs). While abstinence focused approaches posit that sobriety is the only viable mechanism of preventing substance-related consequences, evidence suggests that these approaches may not be effective, feasible, or necessary for all individuals (e.g., Mcgrath, 2004). Additionally, abstinence focused approaches ignore potentially beneficial aspects of substance use, such as the facilitation of transpersonal experiences and intrapersonal growth reported by EDM event attendees. As noted by Witkiewitz & Tucker (2020), interventions that target improved functioning and well-being may be more useful. For example, protective behavioral strategies

(PBS) are a set of harm reduction strategies employed at the individual level to reduce both rate of substance use and severity of consequences (Martens et al., 2004).

Protective Behavioral Strategies

Alcohol

To date, the majority of PBS research has focused on alcohol use (Peterson et al., 2021). In one of the landmark studies of alcohol PBS, Martens et al. (2004) examined the relationship between PBS, alcohol consumption, and alcohol-related consequences among college students. Researchers found that using PBS less frequently was associated with experiencing a greater number of alcohol-related consequences, even when controlling for factors such as level of alcohol consumption and sex assigned at birth. These findings led to the development of the Protective Behavioral Strategies Scale-20 (PBSS-20; Treloar et al., 2015), which is an expansion of the original Protective Behavioral Strategies Scale (PBSS; Martens et al., 2005, 2007) and currently one of the most widely used alcohol PBS measures. The PBSS-20 consists of three distinct subscales: Limiting/Stopping Drinking (e.g., determine not to exceed a predetermined number of drinks), Manner of Drinking (e.g., drink slowly, rather than gulp or chug), and Serious Harm Reduction (e.g., use a designated driver). Overall, a large body of evidence provides support for the efficacy of alcohol PBS, with research consistently demonstrating that individuals who use PBS while drinking are able to avoid or reduce consequences (Bravo et al., 2015, 2016; Pearson, 2013; Prince et al., 2013).

Cannabis

More recently, researchers have begun to study PBS for cannabis use, resulting in the development of the Protective Behavioral Strategies for Marijuana (PBSM) scale (Pedersen et al., 2016, 2017). While the PBSM was found to be composed of a single factor, authors noted

four overarching themes: avoiding use in certain situations (e.g., in public places, while feeling anxious or paranoid), implementing periodic breaks in use, avoiding legal repercussions, and avoiding use until daily responsibilities have been met. Additionally, results indicated that using a greater number of cannabis PBS was associated with using cannabis less frequently and experiencing consequences less often. Subsequent studies have corroborated these findings, such as Bravo et al. (2017) and Prince et al. (2019).

PBS Within the EDM Scene

Very few studies have examined PBS for substances outside of alcohol and cannabis, and validated PBS measurement tools do not yet exist for other drugs. Despite this, there is evidence to suggest that EDM event attendees employ a variety of PBS while attending EDM events, but findings are mixed regarding polysubstance use PBS practices. Fernández-Calderón et al. (2014) collected cross-sectional data on polysubstance use patterns and PBS from 248 participants attending underground raves in Spain. Results suggested that participants used a variety of PBS, with the most frequently endorsed PBS identified as resting after the party, ensuring that substances are completely pulverized prior to snorting, not using with strangers or in uncomfortable environments, and buying drugs from reliable sources. However, findings also indicated that very few participants employed PBS while engaging in polysubstance use. For example, over half of participants reported never or rarely taking precaution to avoid mixing stimulants and approximately 75% of participants reported not taking precautions when mixing alcohol with other drugs.

Only one recent study has examined whether PBS strategies used by EDM event attendees are associated with a significant reduction in substance-related harm (Fernández-Calderón et al., 2019). Results of this cross-sectional study indicated that PBS were significantly

associated with fewer negative consequences, however, researchers focused on PBS related to dosing (e.g., setting a limit on the quantity of a drug to be consumed) in their questionnaire. Further research is needed to determine whether additional PBS strategies utilized within the EDM scene are also associated with fewer adverse outcomes. While dosing PBS are an important tool for reducing harm, these strategies may be ineffective if an individual's drug sample is a different compound than expected (e.g., methamphetamine sold as MDMA) or if their sample is contaminated with fentanyl. Drug checking mechanisms such as reagent test kits and fentanyl test strips are two potential PBS that individuals might use to reduce these adulteration-specific risks.

Reagent Testing

Reagent testing is a cost-effective and accessible method of examining a drug sample to confirm the presence of an individual's desired drug compound (Fatah et al., 2000). Specifically, reagent testing involves colorimetric analysis of a drug sample to confirm the presence of an individual's desired drug compound. Utilizing this PBS may allow individuals to avoid ingestion of unknown and potentially more toxic substances, or provide individuals with pertinent information related to dosing (Palamar & Barrat, 2019). Reagent tests are relatively simple to use and may be easily conducted in the comfort of one's home. Harm reduction organizations such as Dance Safe sell reagent test kits online and provide users with detailed instructions regarding the type of color changes they should expect for different drugs. While this PBS can be extremely beneficial, it is not without limitations. Reagent tests cannot detect all drugs and cannot determine potency or purity. For example, a reagent test may indicate that an individual's drug contains their expected compound, but the drug could still contain other undesired compounds.

Fentanyl Testing

In response to the increased presence of synthetic opioids in the illicit drug supply, fentanyl testing has emerged as a method of checking drugs for fentanyl adulteration (Krieger et al., 2018). Specifically, fentanyl testing involves an individual inserting a test strip into a sample of drugs that has been diluted in water. Since fentanyl is often not uniformly distributed throughout a drug sample, it is recommended for users to test their entire sample, as opposed to just a small portion of it (as with reagent testing). Notably, it is also recommended for users to perform reagent testing on their sample prior to fentanyl testing because there are varying instructions for dilution based on the substance being tested (Bergh et al., 2021). Fentanyl test strips are extremely sensitive—proving to be both a strength and weakness of this PBS. While the strips are effective at detecting trace amounts of fentanyl, the amounts detected may not always be clinically significant and the strips may also produce false positives if used incorrectly (leading to distrust among some PWUD). However, evidence suggests that individuals alter their substance use behavior upon detecting fentanyl in their drug sample. For example, in a study examining the efficacy of a fentanyl test strip distribution program, participants who discovered that their drug sample contained fentanyl were five times more likely to engage in behaviors to avoid overdose (Peiper et al., 2019).

Gaps in Drug-Checking Literature

Research on the use of reagent test kits and fentanyl test strips among EDM event attendees in the U.S. remains limited. One study to-date examining reagent test kit use in this population focused exclusively on testing of MDMA or ecstasy (Palamar & Barratt, 2019) and no studies published at the time of this writing have examined use of FTS among EDM event attendees in the U.S. Critically, synthetic opioids such as fentanyl were involved in

approximately 64% of fatal overdoses documented in 2021 (Ahmad et al., 2021), underscoring the urgent need to characterize FTS use within this at-risk population.

STUDY 1

Overview

Study 1 leveraged an ecologically rigorous field study design to survey a sample of individuals attending a variety of EDM events in the state of Colorado. Data collection was completed in two phases and the aims of the study were to (1) Develop an inventory of general (i.e., non-drug-specific) concert and festival PBS using a community-grounded measurement approach and (2) Establish initial content and criterion validity of the inventory through examining relations between frequency and perceived effectiveness of PBS use and consequences.

Hypotheses

Hypothesis 1a. Mean frequency of PBS use will be inversely associated with mean frequency of experiencing past-year consequences (i.e., participants who endorse more frequent PBS use will report experiencing past-year consequences less frequently).

Hypothesis 1b. Mean frequency of PBS use will be inversely associated with total number of consequences experienced in the past year (i.e., participants who endorse more frequent PBS use will report a lower total number of consequences experienced in the past year).

Hypothesis 2a. Mean perceived effectiveness of PBS will be inversely associated with mean frequency of experiencing past-year consequences (i.e., participants who rate PBS as more effective will report experiencing past-year consequences less frequently).

Hypothesis 2b. Mean perceived effectiveness of PBS will be inversely associated with total number of consequences experienced in the past year (i.e., participants who rate PBS as more effective will report a lower total number of consequences experienced in the past year).

Method

Procedure

Study 1 leveraged a two-phase field study design to survey individuals attending a variety of moderate to large-scale EDM events in Colorado. Phase 1 of data collection (occurring between October 2022 to April 2023) tested the feasibility of using field methods to validate a PBS inventory and served as a mechanism for generating and refining items included in the final inventory. Phase 2 of data collection (occurring between May to September 2023) involved initial steps towards validating the refined PBS inventory that was developed in phase one of data collection. Study procedures and measures were identical for both phases of data collection, with the exception of PBS items (given that a primary aim of phase 1 was to generate additional PBS items and refine the inventory).

In both phases of data collection, participants were recruited while tailgating or waiting in line to enter the event they were attending, a well-established method of recruiting from this population (e.g., Palamar, 2020). Event attendees were asked if they would like to participate in an anonymous 15-minute survey examining substance use at EDM events. Participants completed the study on their own device using a QR code or were provided with a study iPad if their own device was not charged or did not have service. Following completion of the survey, participants were immediately compensated with a commemorative art print or $10 gift card. All event attendees asked to participate in the study were offered free harm reduction supplies (e.g., fentanyl test strips, naloxone), regardless of whether they chose to participate.

Participants

Data was collected from 145 participants (aged 18 to 65) during phase 1 of the study and 305 participants during phase 2. Participants were excluded from the study if they exhibited

visible signs of intoxication (e.g., slurred speech, drowsiness, enlarged pupils) at the time of recruitment and the study was approved by Colorado State University's Institutional Review Board. Participant demographic characteristics are reported in table 1.

Measures

Demographics. Participants were asked to report their age, gender, sex assigned at birth, race, ethnicity, sexual orientation, occupation, and household income.

Substance Use History. Participants selected from a list of 19 drugs (e.g., alcohol, cannabis, psilocybin, MDMA) which substances they have used in their lifetime and in the past year. Participants also reported (from this same list) which substances they planned to use during the event they were entering. Lifetime, past-year, and event-level substance use prevalence rates are reported in table 2.

Substance Use Consequences. Participants were asked to indicate how frequently in the past year they experienced 25 physical or cognitive consequences of substance use on a five-point likert scale (1=never, 5=always). 13 items were adapted from Fernández-Calderón et al. (2019) and an additional 12 items were generated through consultation with community stakeholders.

Protective Behavioral Strategies.

Phase 1. Participants were asked the following open-ended text response question: "Is there anything you do to protect yourself (i.e., to reduce negative or unwanted outcomes) while using drugs and alcohol at Electronic Dance Music (EDM) concerts and festivals? If so, please describe and include how effective you find each strategy to be." After responding to this initial qualitative item, participants were presented with 26 pre-written PBS items based on previous studies of PBS use at EDM events (e.g., Fernández-Calderón et al., 2014, 2019) and my 12 years

of lived experience attending a variety of EDM events (i.e., concerts, clubs, festivals, and underground raves) across the United States (including events in Florida, Georgia, New York, Michigan, Minnesota, Louisiana, and Colorado). Specifically, I generated PBS items related to attendance of multi-day events (items 14-16), avoidance of arrest or event ejection (24), consumption of found substances or "ground scores" (item 22), and binge drinking (item 5). Additionally, while Fernández-Calderón et al. (2014) used a single item for drug checking PBS, I generated two distinct items pertaining to reagent testing (item 20) and use of fentanyl test strips (item 21). I also created an item related to carrying the opioid overdose reversal medication naloxone (item 26), given that fentanyl contamination is an emerging concern within this population.

Participants were asked to indicate how often they use each of the 26 strategies on a six-point likert scale (1=never, 6=always). This response style deviates from Fernández-Calderón et al. (2014; 2019), which used a five-point likert scale (1=never, 5=always), but is consistent with prior alcohol and cannabis PBS studies (e.g., Martens et al., 2005; Pedersen et al., 2016). In line with Fernández-Calderón et al. (2014; 2019), participants were given the option to select "not applicable" if the strategy was not relevant to their personal drug use behavior. Participants were also asked to rate how effective they perceived the strategy to be (5-point likert scale; 1=Not at all, 5=Extremely), regardless of how often they used the strategy. Phase 1 PBS items are reported in table 3.

Phase 2. Following phase 1 of data collection, additional PBS items were generated after individually examining responses to the qualitative PBS question described above. Individual qualitative responses were transformed into inventory items regardless of how many times the PBS appeared in the dataset (i.e., there was no minimum endorsement cutoff that determined

inclusion in the inventory). However, PBS that were deemed to be pseudoscientific (e.g., carrying a crystal) or potentially harmful (i.e., "pre-loading" and "post-loading"; Edwards et al., 2022) were excluded during this process. Perhaps the most striking observation stemming from the qualitative data was the endorsement of PBS related to social processes, which was not fully captured within the phase 1 PBS items. For example, this led to development of items surrounding community solidarity, such as "When attending an event with friends, I make sure to let others in the group know what drugs I am taking" (item 36) and "When using drugs at events, I ensure I am with a good friend or group of friends that I trust (item 35)".

Phase 1 PBS items were also refined based on impromptu verbal feedback from participants during phase 1 data collection. For example, study personnel noted any instances in which participants asked for clarification about the wording of an item. Original items were also refined to capture more generalized substance use behavior, as opposed to drug-specific PBS. For example, instead of referencing specific drug combinations (i.e., "I avoid, or I am cautious about mixing stimulants", "I avoid, or I am cautious about mixing depressants"), these items were refined to a single item, "I avoid, or I am cautious about mixing drugs."

Following additional item generation and refinement of original PBS items, the full 50 item inventory was reviewed by subject matter experts prior to phase 2 data collection. Subject matter experts included clinical psychologists with expertise in polysubstance use and psychometrics, as well as community stakeholders with lived experience of polysubstance use and EDM event attendance. Feedback on readability and essentiality was provided for each item. The instructions given to participants were identical to phase 1 (i.e., participants were asked to indicate how often they use each PBS and rate how effective they find the strategy to be). Phase 2 PBS items are reported in table 4.

Analysis

The goal of phase 1 data collection was to test study feasibility while generating and refining PBS items, therefore data from phase 1 was not analyzed quantitatively. While thematic analysis of open-ended responses was initially considered, I ultimately opted against a data reduction approach. Given that the goal of thematic analysis is to identify common themes or patterns across survey responses (Braun & Clarke, 2006), this method of qualitative analysis may at times prioritize broader trends in the data over distinctive perspectives of individual respondents. Thus, through individual examination and integration of qualitative data (i.e., individual responses were still included in the inventory even if they did not constitute a theme across participants), I aimed to capture the richness and complexity of individual responses, contributing to the development of a nuanced and comprehensive PBS inventory.

Participants were excluded from phase 2 data analysis if they completed less than 70% of the total survey (N=139), ensuring that participants were only included in the analysis if they had viewed all PBS and consequences items. Participants were also excluded from the analysis if they denied past year substance use (N=6), resulting in a phase 2 sample comprised of 160 participants. If participants responded to at least 10 PBS frequency items and 10 PBS effectiveness items, a mean score was generated for both variables. I also generated a mean score for frequency of consequences experienced in the past year and created a new total consequences variable from the existing consequences items described above. Specifically, the 5-point frequency variable was transformed into a binary consequences variable where "never" and "rarely" responses were coded as 0 and all other responses ("sometimes", "often" and, "always") were coded as 1. Items were then summed to create a total consequences variable. A sum score was also calculated for total number of drugs used in the past year.

The total consequences variable was found to be right-skewed (skew = 0.73) and overdispersed (variance = 35.66, mean = 7.68), therefore a series of quasi-Poisson regressions were used to examine relations between total consequences and PBS variables (i.e., frequency and perceived effectiveness), while controlling for total drugs used in the past year. As noted by Baggio et al. (2018), quasi-Poisson models are optimal for handling skewed and overdispersed count data in substance use research. Additionally, quasi-Poisson models use a log link function, which allows for the generation of incident rate ratios (IRRs) through exponentiation of logits. Specifically, IRRs are interpreted as the percent change in the outcome per one unit change in the independent variable, when all other independent variables in the model are held constant. Use of IRRs facilitated a straightforward interpretation of the quasi-Poisson models by allowing me to determine whether increased use of PBS and increased perception of PBS effectiveness was associated with a decrease in the expected count of consequences.

The mean consequences variable was right-skewed (skew = .823). Thus, to examine relations between mean consequences and PBS variables, I fit a series of Generalized Linear Models (GLM) with a gamma distribution and a log-link function (again controlling for past year drug use). Gamma GLM is appropriate for modeling continuous and skewed variables in psychology (Ng & Cribbie, 2017). Exponentiation of logits in gamma GLM produces rate ratios (RRs), interpreted as the percent change in the outcome per one unit change in the independent variable, when all other independent variables in the model are held constant. Interpretation of RRs allowed me to determine whether increased use of PBS and increased perception of PBS effectiveness was associated with a decrease in the expected rate of experiencing consequences.

Results

Descriptive Statistics

Table 2 presents participant prevalence rates for lifetime, past-year, and event-level substance use across 19 drugs. Alcohol (73.1-93.8%), cannabis (53.1-86.9%), and tobacco/nicotine (41.9-72.5%) products were the most commonly used substances across all three timeframes. After alcohol, cannabis, and tobacco/nicotine products, MDMA (20.6-70.0%), psilocybin (20-69.4%), LSD (15.6-65%), and cocaine (11.3-65.6%) were the next most commonly used drugs. This was followed by ketamine (11.3-41.9%), nitrous oxide (1.9-33.8%), and prescription stimulants (2.5-34.4%).

Quasi-Poisson Model Results

Model 1: Relation between Frequency of PBS use and Total Consequences. Quasi-Poisson model 1 examined the relation between frequency of PBS use and total consequences, while controlling for past-year drug use. Results indicated a significant negative association between frequency of PBS use and total consequences (β = -0.219, SE = 0.078, p = 0.005, IRR = 0.80). This indicates that for every one unit increase in frequency of PBS use, the expected count of unique past year consequences decreased by 20%. No significant association between past-year drug use and consequences was observed (β = 0.032, SE = 0.018, p = 0.082, IRR= 1.03).

Model 2: Relation between Perceived PBS Effectiveness and Total Consequences. Quasi-Poisson model 2 examined the relation between perceived PBS effectiveness and total consequences, while controlling for past-year drug use. Results revealed a significant negative association between perceived PBS effectiveness and total consequences (β = -0.254, SE = 0.090, p = 0.005, IRR = 0.78). This indicates that for every one unit increase in perceived PBS effectiveness, the expected count of unique past year consequences decreased by 22%. Again, no

significant association emerged between past-year drug use and total consequences (β = 0.029, SE = 0.018, p = 0.103, IRR = 1.03).

Gamma Model Results

Model 1: Relation between Frequency of PBS use and Frequency of Experiencing Consequences. Gamma Model 1 examined the relation between frequency of PBS use and frequency of experiencing consequences in the past year, while controlling for past-year drug use. Results revealed a significant negative association between frequency of PBS use and frequency of consequences (β = -0.125, SE = 0.036, p < 0.001, RR = 0.88). This indicates that for every one unit increase in frequency of PBS use, there was a 12% reduction in the expected rate of experiencing consequences. Results also revealed a significant positive association between past-year drug use and frequency of experiencing consequences (β = 0.016, SE = 0.008, p = 0.045, RR = 1.02). This suggests that for each additional drug used in the past year, there was a 2% increase in the expected rate of experiencing consequences.

Model 2: Relation between Perceived PBS Effectiveness and Frequency of Experiencing Consequences. Gamma Model 2 examined the relation between perceived effectiveness of PBS and frequency of experiencing past-year consequences, while controlling for past-year drug use. Perceived PBS effectiveness was found to be negatively associated with frequency of past-year consequences (β = -0.148, SE = 0.042, p < 0.001, RR = 0.86). This suggests that for every one unit increase in perceived PBS effectiveness, there was a 14% decrease in the expected rate of experiencing consequences. Past year drug use was again positively associated with frequency of consequences in this second model (β = 0.016, SE = 0.008, p = 0.047, RR = 1.02). This suggests that for each additional drug used in the past year,

there was a 2% increase in the expected rate of experiencing consequences. Quasi-Poisson and gamma model results are listed in table 5.

Discussion

The vast majority of PBS research to date has focused on strategies used to protect against harmful effects of a single substance, almost exclusively with a focus on alcohol or cannabis (Peterson et al., 2021). Moreover, there remains a paucity of research on PBS use in community samples (i.e., most studies have been conducted with college student populations) and current PBS measures largely do not account for contextual factors (e.g., the setting or environment in which drug use takes place). These shortcomings represent a substantial gap in the harm reduction literature, as polysubstance use has become increasingly common in the U.S. and confers exponentiated risks in comparison to single-substance use (e.g., Baggio et al., 2014; Morley et al., 2015).

Within the socio-cultural context of dance music events, polysubstance use is ubiquitous and associated with increased incidence of experiencing adverse substance-related outcomes (Palamar, 2019). Additionally, EDM events pose unique environmental risks (e.g., dense crowded dance floors, ambient heat, extended periods of drug use) that underscore the importance of identifying strategies that this population might use to keep themselves safe while using multiple drugs (Palamar & Sönmez, 2022). In the current study, I sought to develop a non-drug-specific polysubstance use PBS inventory and complete initial steps towards validating the inventory in a sample of EDM event attendees in Colorado. To this end, I leveraged a two-part field study design with the goal of prioritizing ecological and content validity, while elevating the lived experiences of community stakeholders.

Phase 1 Feasibility: Practical Challenges and Lessons Learned

Phase 1 of the study involved exploring the feasibility of using field methods to develop a polysubstance use PBS inventory and generating additional PBS items based on qualitative data. Time constraints were found to be one of the largest barriers to using field methods for inventory development. Specifically, to establish convergent and discriminant validity of an inventory, there is a need to include established measures within the study design, which ultimately extends the length of a survey (DeVellis & Thorpe, 2021). There is also a need to include items related to sample characterization (e.g., demographic characteristics, substance use patterns) in order to ascertain who the measure is validated for. Outside of field methodologies, extended survey length presents concerns related to participant fatigue and drop-out, which can contribute to reductions in data quality (Galesic & Bosnjak, 2009). However, these concerns are amplified within field contexts, particularly when collecting data in an environment marked by recreational enjoyment. For example, in the current study (which was approximately 10-15 minutes in length), just a little over half of phase 2 participants (53.5%) completed enough of the survey (70% completion cutoff) to be included in analyses. Thus, while the study maximized ecological validity, there was a notable tradeoff of participant retention and the number of items able to be included in the survey (e.g., the current study did not include a discriminant validity measure and some items pertaining to drug consumption behaviors were omitted prior to phase 2 data collection).

During phase 1 data collection, there were notable improvements to participant retention when researchers remained with participants throughout the duration of the survey. This allowed participants to ask questions about specific survey items and reduced distractions inherent to collecting data in a recreational context. In turn, this led to an increased need for study personnel

during phase 2, which introduced some feasibility challenges. In particular, study personnel consisted of volunteer research assistants and most data collection periods lasted approximately six hours (including two or more hours of travel to and from events). These heightened personal demands underscored the importance of strategically selecting events anticipated to attract a larger crowd of attendees during phase 2 data collection (as to ensure efficient allocation of recruitment resources). The protocol described above deviates from previous studies of EDM event attendees, wherein events were randomly selected. While introducing some selection bias, strategical selection of events was found to be necessary for feasibility purposes. Notably, most extant studies of EDM event attendees in the U.S. have occurred in New York City (e.g., Palamar, 2020; Palamar & Barratt, 2019; Palamar, Acosta, Cleland et al., 2019). Random selection of events is likely more practical in places such as New York City (in comparison to Fort Collins, Colorado) given the city's walkability, robust public transportation system, and greater frequency of large-scale events. Additionally, no extant field studies with this population have attempted inventory development, which again increases study duration and necessitates adaptations to address practical constraints of recruitment.

Content Validity and Community Engagement

In addition to testing study feasibility, a primary goal of phase 1 data collection was to refine existing PBS items and generate additional items based on qualitative data. While study personnel did not explicitly solicit survey feedback from respondents, many participants were eager to contribute to the goals of the study and provided spontaneous verbal feedback following survey completion. This included discussion of harm reduction practices and sharing of lived experiences related to drug use and addiction. Participants were also able to ask researchers

questions about survey items while completing the study, which aided in community-driven refinement of the inventory through increased clarity and readability of items.

In sum, the process used to refine phase 1 PBS items and generate additional phase 2 PBS items constitutes a major strength of the current study. As noted by Boness et. al. (2023), few studies in the psychological sciences have included individuals with lived experience in the measure development process, particularly during the preliminary evaluation stage. Critically, inclusion of community stakeholders in this process not only facilitates comprehensive coverage of a domain (i.e., content validity), but also bolsters the utility of a measure for serving its intended purpose (e.g., clinical or public health interventions).

Criterion Validity

To establish initial criterion validity of the PBS inventory, I examined the relation between PBS (i.e., mean frequency of use and mean perceived effectiveness) and consequences (i.e., total unique past-year consequences and mean past-year frequency of experiencing consequences), while controlling for past-year drug use (i.e., total number of drugs used in the past-year). As hypothesized, using PBS more frequently and perceiving them to be more effective was associated with experiencing fewer unique past-year consequences. More frequent PBS use and greater perceived effectiveness was also associated with experiencing consequences less frequently in the past year. These findings lend early support for the inventory's criterion validity though demonstrating its ability to capture the underlying construct of polysubstance use PBS within the context of consequences. Specifically, the inventory could successfully distinguish between participants who use PBS more frequently and perceive them to be more effective from those who use less frequently and perceive PBS to be less effective. Establishing the relation between PBS and consequences has been critical to prior PBS measure development

studies, as the overarching goal of PBS is to reduce substance-related harms (Martens et al., 2005; Pedersen et al. 2016).

Limitations and Future Directions

This study is limited by its cross-sectional design, reliance on participant self-report, and relative homogeneity with regard to demographic characteristics (i.e., race, ethnicity, gender identity, education, and household income). Additionally, findings may not be generalizable outside of concert and festival contexts. While ecological, content, and criterion validity were strengths of the current study, additional evaluation of psychometric properties is necessary prior to inventory application. For example, next steps include testing convergent validity of the inventory, which would involve assessing the relation between polysubstance use PBS variables and existing measures of similar constructs. Specifically, polysubstance use PBS should be positively associated with existing measures of alcohol and cannabis PBS.

Future directions might also include implementation of data reduction techniques such as principal components analysis (PCA) or exploratory factor analysis (EFA). The central aim of the current study was to develop a nuanced and comprehensive inventory of polysubstance use PBS, thus data reduction techniques would have been inappropriate at this stage. However, a condensed measure of polysubstance use PBS may have utility for brief front-line harm reduction interventions. Critically, should future research involve application of data-reduction techniques, collaboration with community stakeholders should be used to ensure essential items are not deleted (Boness et al., 2023).

Following additional evaluation of psychometric properties, the inventory developed in this study could be used to inform personalized harm reduction interventions involving psychoeducation around safer polysubstance use practices. The inventory could also be used as a

measure of intervention efficacy (e.g., through comparison of pre-and-post polysubstance use PBS scores) or therapeutic progress when working within a harm reduction psychotherapy framework. At the community level, this study could inform education and awareness campaigns through harm reduction organizations such as Dance Safe or Harm Reduction Circle, which already have an existing presence within the dance music community. Additionally, event organizers could incentivize attendees to engage with educational materials to promote health and wellness among concert and music festival patrons. Ultimately, dissemination efforts should be guided though consultation with stakeholders in order to best serve community members' needs.

Conclusion

EDM event attendees employ a variety of PBS to protect themselves while engaging in polysubstance use at concerts and festivals. Polysubstance use PBS include strategies related to collective community welfare (e.g., "When attending an event with friends, I make sure to let others in the group know what drugs I am taking"), dosing practices (e.g., "If I am mixing drugs, the quantity I take of each drug is lower than if I take them separately"), mindfulness and body awareness (e.g., "I check in with myself while using drugs to see how I am feeling"), environmental safety (e.g., "Before using drugs at an event, I familiarize myself with the location of medical stations and/or harm reduction services"), and minimizing risks associated with an unregulated illicit drug supply (e.g., "I analyze my drugs with fentanyl test strips when applicable"). Using polysubstance use PBS more frequently may help individuals attending EDM events to reduce substance-related harms. Given that perceived effectiveness of PBS was also linked to reduced harm, interventions aimed at increasing beliefs related to PBS efficacy may be useful.

STUDY 2

Overview

Study 2 employed a field study design to explore polysubstance use patterns and drug checking behaviors more deeply among attendees of a 4-day music festival in Colorado. Specifically, I aimed to characterize the most common drug use patterns on each day of the festival, prevalence of using reagent test kits and fentanyl test strips, which substances attendees reported testing, and behavior in response to drugs testing differently than expected (i.e., consumption vs. discarding of drug sample). No directional hypotheses were generated, as study 2 was exploratory in nature.

Method

Participants

Participants (Table 1) were 227 music festival attendees recruited from Sonic Bloom Music Festival in Rye, Colorado. Participants were excluded from the study if they exhibited visible signs of intoxication (e.g., slurred speech, drowsiness, enlarged pupils) at the time of recruitment and the study was approved by Colorado State University's Institutional Review Board.

Procedure

Sonic Bloom attendees were recruited from the festival campground prior to entering the event for the day and asked if they would like to participate in an anonymous survey on substance use and harm reduction. Participants completed the study on their own device using a QR code or were provided with a study iPad if their own device was not charged or did not have service. Following completion of the survey, participants were immediately compensated with a

commemorative art print created by the first author of the study. All individuals asked to participate in the study were offered free harm reduction supplies (e.g., fentanyl test strips, naloxone), regardless of whether they chose to participate.

Measures

Demographics. Participants were asked to report information pertaining to age, gender, sexual orientation, ethnicity, race, level of education, and household income.

Substance Use. Participants were asked to report their lifetime and past year use of 22 substances (e.g., alcohol, cannabis, MDMA, cocaine, LSD), as well as their event-level substance use (i.e., substance use from previous event days in addition to planned use throughout the remainder of the festival). For example, if recruitment occurred on day three of the festival, participants were asked to report on their substance use during days one and two, as well as their planned use for days three and four. Lifetime, past year, and event-level substance use is listed in Table 2.

Reagent Testing. Participants were asked whether they have ever reagent tested their drugs and prompted to select all of the following options that apply to them: "Yes, I have personally tested my drugs with reagents", "Yes, a harm reduction organization has tested my drugs with reagents", "Yes, a friend or family member has tested my drugs with reagents", "Yes, a dealer has tested my drugs with reagents", Yes, an entity not listed here has tested my drugs with reagents", and "No, I have never tested my drugs with reagents". If participants endorsed engagement in reagent testing (either personally or through another person/agency), they were asked to report how often they ensure their drugs are reagent tested prior to consumption on a 5-point Likert scale (1=Never, 2=Sometimes, 3=About half the time, 4=Most of the time, 5=Always). Participants were then asked to select which drugs they had ever tested before with

reagents and to indicate whether their drug sample has ever tested differently than expected (i.e., following reagent testing, the participant suspected their sample contained a different compound than what was sold to them). If participants reported having an experience where their drug sample did not test as expected, they were asked whether they had ever consumed a drug that tested differently than expected.

Fentanyl Test Strips. FTS items and branching logic were identical to that of the reagent testing items. However, an additional question also prompted participants to indicate from a list which of their drugs had ever tested positive for fentanyl using FTS.

Analysis

Data were analyzed using IBM SPSS Statistics for Windows version 29. Data cleaning procedures were performed using recommendations from Tabachnick and Fidell. Specifically, univariate outliers (scores of ≥3.29 standard deviation, a likelihood of $p<0.001$) were examined individually and adjusted by reducing outlying values to one score above the next highest value in the distribution. Given the exploratory nature of study 2 and overall goal of characterizing drug checking behavior in the population, I primarily report descriptive statistics. However, repeated measures ANOVA was used to examine whether polysubstance use patterns (i.e., total number of drugs used) varied significantly by festival event day. Greenhouse-Geisser, Huynh-Feldt, and Lower-bound corrections were applied to adjust for violations of sphericity.

Results

Polysubstance Use

The drugs that attendees most commonly endorsed using on any given day of the festival were alcohol (53.7% to 68.3%), cannabis (60.8% to 68.3%) and tobacco/nicotine products (50.7% to 55.9%). After alcohol, cannabis, and tobacco/nicotine products, the most commonly

endorsed substances were ketamine (36.6%), psilocybin (24.7%), and cocaine (24.2%) on day 1, psilocybin (38.3%), ketamine (36.3%), and MDMA (33.9%) on day 2, MDMA (46.7%), LSD (40.1%), and ketamine (38.8%) on day 3, and ketamine (29.1%), psilocybin (23.8%), and cocaine (21.1%) on day 4.

Results revealed a significant main effect of festival event day on total number of drugs used ($F(2.449, 553.370) = 53.165$, $p < .001$). Within-subjects contrasts indicated that the effect of festival event day on total number of drugs used was characterized by a significant quadratic ($F(1, 224) = 175.248$, $p < .001$) and cubic ($F(1,224) = 9.938$, $p = .002$) component, but the linear component was not significant ($F(1,224) = 0.114$, $p = .736$). This suggests that participants used a greater mean number of drugs on days 2 and 3 of the festival in comparison to days 1 and 4.

The mean number of substances reported on day 1 was 3.21 (*SD*=2.52), with 30% of participants reporting simultaneous use of two or three drugs, 28.2% reporting simultaneous use of four or five drugs, and 14.5% reporting simultaneous use of greater than 5 drugs. The mean number of substances reported on day 2 was 4.05 (*SD*=2.42), with 29.5% of participants reporting simultaneous use of two or three drugs, 32.1% reporting simultaneous use of four or five drugs, and 24.6% reporting simultaneous use of greater than 5 drugs. The mean number of substances reported on day 3 was 4.33 (*SD*=2.59), with 25.6% of participants reporting simultaneous use of two or three drugs, 34.3% reporting simultaneous use of four or five drugs, and 28.2% reporting simultaneous use of greater than 5 drugs. Finally, the mean number of substances reported on day 4 was 3.16 (*SD*=2.55), with 33.5% of participants reporting simultaneous use of two or three drugs, 24.6% reporting simultaneous use of four or five drugs, and 15.2% reporting simultaneous use of greater than 5 drugs. Polysubstance use patterns are reported in table 2.

Reagent Test Kits

When asked about prior use of reagent tests, 54.2% of participants selected “Yes, I have personally tested my drugs with reagents”, 7% of participants selected “Yes, a harm reduction organization has tested my drugs with reagents”, 25.6% of participants selected “Yes, a friend or family member has tested my drugs with reagents”, 22.9% of participants selected “Yes, a dealer has tested my drugs with reagents”, 0.9% of participants selected “Yes, an entity not listed here has tested my drugs with reagents”, and 24.7% of participants selected “No, I have never tested my drugs with reagents”. When asked how often participants ensure their drugs are reagent tested prior to consumption, 27.2% of participants responded “always”, 27.2% of participants responded “most of the time”, 10.7% of participants responded “about half of the time”, 29.6% of participants responded “sometimes”, and 5.3% of participants responded “never”.

The most common drugs that participants reported testing with reagents included MDMA (61.7%), cocaine (48.9%), ketamine (37%), and LSD (18.1%). However, some participants also reported testing drugs such as psilocybin (5.3%), DMT (4%), 2c series chemicals (4%), methamphetamine (3.5%), prescription anti-anxiety (2.6%), prescription stimulants (1.8%), and prescription pain killers (1.8%). When asked to report whether their drug sample has ever tested differently than expected (i.e., the participant suspected their sample contained a different compound than what was sold to them), 44.4% of participants responded “yes” and 55.6% of participants responded “no”. When asked to report if they have ever consumed a drug that tested differently than expected (*N*=76), 39.2% of participants responded “yes” and 60.8% of participants responded “no”. Reagent test kit use patterns are reported in table 3.

Fentanyl Test Strips

When asked about prior FTS use, 50.7% of participants selected “Yes, I have personally tested my drugs with fentanyl test strips”, 6.6% of participants selected “Yes, a harm reduction organization has tested my drugs with fentanyl test strips”, 13.7% of participants selected “Yes, a friend or family member has tested my drugs with fentanyl test strips”, 9.3% of participants selected “Yes, a dealer has tested my drugs with fentanyl test strips”, 0.4% of participants selected “Yes, an entity not listed here has tested my drugs with fentanyl test strips”, and 33.5% of participants selected “No, I have never tested my drugs with fentanyl test strips”. When asked how often participants ensure their drugs are tested for fentanyl prior to consumption, 30.7% of participants responded “always”, 28.7% of participants responded “most of the time”, 6% of participants responded “about half of the time”, 30% of participants responded “sometimes”, and 4.7% of participants responded “never”.

The most common drugs that participants reported testing with FTS included MDMA (48.5%), cocaine (42.7%), and ketamine (28.6%). Less commonly, participants also reported testing DMT (4.4%), prescription anti-anxiety (4%), LSD (3.5%), psilocybin (2.6%), prescription pain killers (2.2%), prescription stimulants (1.8%), 2C series chemicals (1.3%), peyote/mescaline (0.4%), heroin (0.9%), methamphetamine (0.9%), and cannabis (0.4%). When asked to report whether their drug sample has ever tested positive for fentanyl, 22% of participants responded “yes” and 78% of participants responded “no”. Additionally, the following drugs were reported by participants to have tested positive for fentanyl: MDMA (7.5%), cocaine (5.7%), ketamine (3.1%), prescription pain killers (1.8%), prescription stimulants (1.3%), methamphetamine (0.9%), heroin (0.9%), prescription anti-anxiety (0.9%), LSD (0.4%), peyote/mescaline (0.4%), 2C series chemicals (0.4%) and cannabis (0.4%). When

asked to report if they have ever consumed a drug that tested positive for fentanyl, 12.1% of participants responded “yes” and 87.9% of participants responded “no”. Fentanyl test strip use patterns are reported in table 4.

Discussion

Polysubstance use is common at EDM events and places event attendees at increased risk of experiencing adverse outcomes (Barrett et al., 2005). Hazards associated with polysubstance use are exacerbated when people who use drugs are unaware of the contents of their drug sample, particularly within the context of the U.S.’s ongoing overdose epidemic and a toxic and unregulated illicit drug supply (Figgatt et al., 2021; Konefal et al., 2022). Reagent test kits and fentanyl test strips are two efficacious drug checking tools that EDM event attendees might use to protect themselves from risks associated with contamination, adulteration, and misrepresentation of unregulated illicit substances. The current study sought to investigate polysubstance use patterns among attendees of a 4-day music festival in the U.S. and characterize use of reagent test kits and fentanyl test strips in this population (e.g., prevalence of use, behavior in response to drugs testing differently than expected).

When examining overall substance use among festival attendees, I observed differential patterns of polysubstance use that varied significantly by event day. Specifically, participants used a greater total number of drugs on Friday (day 2) and Saturday (day 3) than on Thursday (day 1) and Sunday (day 4). Additionally, psychedelic use (i.e., psilocybin, LSD) tended to be more common on Friday and Saturday of the festival. One possible explanation for this finding is that individuals may have engaged with the harm reduction strategy of pacing themselves on day 1 to avoid building tolerance and to increase enjoyment of latter festival days. For example, psychological tolerance to LSD is known to manifest substantially 24 hours after administration

and can also result in cross-tolerance to other psychedelic compounds such as psilocybin and mescaline (Buchborn et al., 2016). Further, given that attendees were required to leave the festival grounds on the Monday following day 4 of the festival, attendees may have decreased their drug use to prepare themselves for next-day travel (particularly given that this event took place in a somewhat remote location). Ultimately, additional research is needed to disentangle polysubstance use patterns at multi-day music festivals. Doing so has important implications for allocation of harm reduction resources at events and maximizing preparedness of festival staff to respond to medical emergencies.

Most festival attendees reported at least one incidence of testing their drugs with reagent test kits (75.3%) or FTS (66.5%), however, among participants who reported testing their drugs, 26.9% shared that they have never personally tested their drugs with reagents and 19.7% shared that they have never personally tested their drugs with FTS. Given that a large proportion of attendees reported reliance on others (e.g., friend, drug seller) to test their drugs for them, there may be a need for interventions aimed at encouraging individuals to test their own drugs when possible. Aside from utilizing drug checking services through a harm reduction organization, testing one's own drugs is likely the best way for an individual to ensure that proper testing procedures are adhered to. For example, drug sellers' motives for drug checking may not always align with consumer safety, particularly within a festival context where drug sales often occur within an isolated purchase (Palamar & Sönmez, 2022). However, a recent qualitative study of formal (e.g., harm reduction organization) and informal (e.g., drug seller) drug checkers in the U.S. found that drug sellers' motives for drug checking included an altruistic desire to protect their clients, while also serving as a marketing tool (Palamar, Acosta, Sutherland, et al., 2019).

MDMA, cocaine, and ketamine were the most common drugs that participants reported testing, which may be due to knowledge that powders and tablets are more likely to contain adulterants/contaminants in comparison to plant material such as cannabis or mushrooms (Cole et al., 2011). However, some participants nevertheless endorsed testing of plant material, with one participant reporting an incidence in which they suspected their cannabis tested positive for fentanyl. Currently, there is little evidence supporting the intentional adulteration of cannabis with fentanyl or fentanyl analogues. While accidental contamination is possible, participants of the current study were not asked to detail the testing procedures followed or describe their interpretation of test results. Therefore, while it would be impossible to draw conclusions on the accuracy of this report, this is particularly unlikely given that the study took place in Colorado, a state with a legal and regulated cannabis market.

Among participants who reported an instance in which their drugs tested differently than expected using reagents, 60.8% of participants reported that they had never consumed a drug that tested differently than expected and 39.2% shared that they had. Importantly, participants were not asked to report how many times this has occurred, so it is unclear whether this would have been a regular practice or a "one-off" occurrence if consumption was endorsed. I'd also like to note that choosing to consume a substance that tests differently than expected does not necessarily imply lack of behavior change. Participants may have altered their dose of the drug after discovering it was a different substance or engaged with other risk reduction strategies such as informing a trusted friend of their consumption. Among participants who reported an instance in which their drugs tested positive for fentanyl using FTS, 87.9% of participants shared that they have never consumed a substance that tested positive for fentanyl, and 12.1% reported that

they had. This finding speaks to the critical importance of FTS in empowering festival attendees to make informed decisions related to their substance use and health.

Limitations and Future Directions

This study is limited by its cross-sectional design, reliance on participant self-report, and relative homogeneity with regard to demographic characteristics (i.e., race, ethnicity, gender identity, education, and household income). Additionally, findings may not be generalizable outside of festival contexts and participants were not asked to report on their frequency of substance use or other consumption variables such as dosing patterns, route of administration, or age of first use. Future directions include replication with a more diverse sample and extension to other high-risk recreational contexts. This area of research would also benefit from application of longitudinal designs (e.g., daily diary) to understand drug checking patterns and behavior in response to drug checking over time. Future studies should also investigate why individuals might decide to consume a drug after it tests differently than expected and request for participants to detail specific drug checking procedures that were followed. Finally, understanding barriers to drug checking within festival contexts is also critical to best serving the needs of community members.

Study 1. Table 1. Respondent Demographic Characteristics

Characteristics	N	%	M	SD	Min	Max
Age			27.71	5.23	18	41
Gender						
Agender	1	0.6				
Gender fluid	4	2.5				
Gender queer	4	2.5				
Man	65	40.9				
Woman	81	50.9				
Non-binary	2	1.3				
Prefer not to answer	2	1.3				
Transgender						
Yes	2	1.3				
No	155	98.1				
Prefer not to answer	1	0.6				
Ethnicity						
Arab, Middle Eastern, or North African	16	10.0				
Asian or Asian American	12	7.5				
Black or African American	11	6.9				
Hispanic or Latino	21	13.1				
Native American or Alaska Native	11	6.9				
Native Hawaiian or Other Pacific Islander	8	5.0				
White or European American	106	66.3				
Not listed	1	0.6				
Prefer not to answer	6	3.8				
Race						
Asian	6	3.8				
Black	6	3.8				
Indigenous, Aboriginal, or First Nations	1	0.6				
Latino or Hispanic	21	13.1				
Middle Eastern	2	1.3				
White	129	80.6				
Not listed	1	0.6				
Sexual Orientation						
Straight or heterosexual	94	58.8				
Lesbian	9	5.6				
Gay	3	1.9				
Bisexual	31	19.4				
Pansexual	18	11.3				
Sexually fluid	6	3.8				
Queer	6	3.8				
Demisexual	1	0.6				
I use a different term	1	0.6				
Prefer not to answer	2	1.3				

Education		
Less than high school	1	0.7
High school diploma or GED	23	15.0
Some college	35	22.9
Associates degree or technical certification	20	13.1
Bachelor's degree	49	32.0
Master's degree	16	10.5
Doctoral degree	9	5.9
Household Income		
$0-$9,999/yr	4	2.6
$10,000-$19,999/yr	9	5.8
$20,000-$29,999/yr	18	11.6
$30,000-$39,999/yr	18	11.6
$40,000-49,999/yr	19	12.3
$50,000-$59,999/yr	14	9.0
Over $60,000/yr	73	47.1

Note. M, mean. SD, standard deviation

Study 1. Table 2. Respondent Substance Use

Drug endorsed	Lifetime use		Past-year use		Event-level use	
	N	**%**	**N**	**%**	**N**	**%**
No use	0	0	0	0	5	3.1
Tobacco/nicotine	116	72.5	104	65.0	67	41.9
Alcohol	150	93.8	137	85.6	117	73.1
Cannabis	139	86.9	119	74.4	85	53.1
MDMA	112	70.0	89	55.6	33	20.6
LSD	104	65.0	80	50.0	25	15.6
Cocaine	105	65.6	72	45.0	18	11.3
Psilocybin	111	69.4	99	61.9	32	20.0
DMT	50	31.3	37	23.1	1	0.6
Peyote/mescaline	13	8.1	11	6.9	0	0
2C series	11	6.9	13	8.1	1	0.6
Ketamine	67	41.9	53	33.1	18	11.3
Nitrous oxide	54	33.8	40	25.0	3	1.9
Poppers	31	19.4	23	14.4	0	0
GHB	7	4.4	10	6.3	0	0
Heroin	3	1.9	8	5.0	0	0
Methamphetamine	13	8.1	8	5.0	0	0
Prescription pain killers	31	19.4	11	6.9	0	0
Prescription stimulants	55	34.4	35	21.9	4	2.5
Prescription anti-anxiety	41	25.6	16	10.0	0	0

Study 1. Table 3. Phase 1 Protective Behavioral Strategies

1. I avoid, or I am cautious about mixing depressants (alcohol, GHB, opiates, etc.)
2. I avoid, or I am cautious about mixing stimulants (cocaine, methamphetamine, ecstasy, etc.)
3. If I am mixing drugs, the quantity of each of them I take is lower than if I take each of them separately.
4. I avoid, or I am cautious about mixing alcohol with other drugs.
5. I avoid binge drinking (consuming 5 or more drinks in a single session)
6. I set a limit on the quantity of a drug I will take and try not to exceed it.
7. During a party, I wait for the effects of a dose to decrease before taking another one.
8. I avoid sharing snorting devices.
9. I completely pulverize or mince what I'm going to snort.
10. I avoid consuming if I am sad, depressed, or if I am going through a rough patch.
11. I pause when dancing to take a rest.
12. I hydrate with water, soft drinks, or isotonic drinks.
13. I take a good rest after the party.
14. When attending multi-day events, I make sure get a least 4 hours of sleep each day.
15. When attending multi-day events, I make sure to eat at least 1 meal per day.
16. When attending multi-day events, I take a rest day (i.e., a day where I either reduce my drug use or avoid using drugs).
17. I avoid consuming with strangers and/or in environments where I do not feel comfortable.
18. I buy drugs from reliable or known sources.
19. I plan my drug use sessions instead of using what someone offers.
20. Prior to consuming a drug, I analyze my sample using reagent testing.
21. Prior to consuming a drug, I analyze my sample for the presence of fentanyl (e.g., fentanyl test strips).
22. I avoid consuming unknown substances that I find on the ground (i.e., "ground scores").
23. If I do not know the purity of a drug, I take a test dose to appraise it.
24. I am cautious to avoid using drugs in front of law enforcement officers or event security.
25. If I am in a crowd and I start to feel overheated, I leave the crowd and take a break
26. I carry naloxone (e.g., Narcan).

Study 1. Table 4. Phase 2 Protective Behavioral Strategy Item Difficulty

Protective Behavioral Strategies *Frequency of use (1=never, 6=always)* *Perceived effectiveness (1=not at all, 5=very)*	**Frequency of use**		**Perceived effectiveness**	
	M	**SD**	**M**	**SD**
1. I avoid, or I am cautious about mixing drugs.	4.28	1.71	3.87	1.16
2. If I am mixing drugs, the quantity I take of each drug is lower than if I take them separately	4.67	1.43	3.86	1.10
3. I avoid, or I am cautious about mixing alcohol with other drugs	4.18	1.79	3.85	1.26
4. When trying a new drug combination, I research the potential risks and interactions of the drugs I am taking beforehand	4.65	1.67	3.98	1.27
5. I avoid binge drinking (consuming 5 or more drinks in a single session)	4.22	1.74	3.85	1.24
6. I set a limit on the quantity of a drug I will take and try not to exceed it	4.69	1.50	4.06	1.17
7. I wait for the effects of a drug to decrease before taking more	4.28	1.61	3.91	1.13
8. I take smaller doses of a drug instead of larger doses	4.58	1.49	3.79	1.19
9. I research the effects of a particular drug dosage beforehand	4.59	1.68	4.02	1.21
10. I weigh out my drug doses when applicable	4.21	1.79	4.02	1.25
11. I pause when dancing to take a rest	4.32	1.57	3.89	1.08
12. I hydrate with water, soft drinks, or isotonic drinks.	5.35	1.24	4.48	0.93
13. I take a good rest after the event	5.03	1.33	4.27	1.08
14. I carry snacks and water with me when I attend events	4.63	1.55	4.09	1.14
15. When attending multi-day events, I make sure to get at least 4 hours of sleep each day	5.04	1.32	4.20	1.11
16. When attending multi-day events, I make sure to eat at least 1 meal per day.	5.45	1.17	4.37	1.05
17. When attending multi-day events, I take a rest day (i.e., a day where I either reduce my drug use or avoid using drugs).	4.07	1.70	3.91	1.14
18. I pace myself when attending multi-day events	4.83	1.31	4.11	1.12
19. I buy drugs from reliable or known sources.	5.20	1.33	4.47	0.94
20. I plan my drug use sessions instead of using what someone offers.	4.88	1.42	4.29	1.02
21. I analyze my drugs with reagent tests when applicable	4.36	1.80	4.12	1.19
22. I analyze my drugs with fentanyl test strips when applicable	4.38	1.85	4.08	1.32
23. I avoid consuming unknown substances that I find on the ground (i.e., “ground scores”).	5.16	1.56	4.67	0.74
24. If I do not know the strength or purity of a drug, I take a smaller dose to test it	4.70	1.70	4.28	1.03
25. I carry naloxone (e.g., Narcan) with me when attending events	2.81	1.98	3.44	1.71
26. I avoid accepting drinks and other drugs from strangers	4.87	1.62	4.24	1.06
27. I avoid leaving drinks unattended	5.41	1.26	4.55	0.85
28. I am cautious to avoid using drugs in front of law enforcement officers or event security.	5.48	1.03	4.46	0.91
29. I am cautious to avoid buying/selling drugs in front of law enforcement officers or event security	5.63	1.11	4.68	0.68
30. I take caution to hide my drugs well when going through event	5.62	0.95	4.57	0.76

security				
31. I pregame before the event and then sober up during the show if I have to drive	4.49	1.74	4.22	1.08
32. I use a designated driver (e.g., sober friend, Uber, taxi) when needed	5.12	1.31	4.54	0.84
33. I avoid using drugs alone	4.60	1.51	4.22	1.12
34. When attending an event with friends, I devise a plan beforehand in case the group gets split up (e.g., designating a meeting spot)	4.84	1.45	4.30	1.00
35. When using drugs at events, I ensure I am with a good friend or group of friends that I trust	5.44	1.10	4.50	0.96
36. When attending an event with friends, I make sure to let others in the group know what drugs I am taking	5.36	1.03	4.49	0.84
37. I avoid consuming with strangers and/or in environments where I do not feel comfortable.	5.02	1.42	4.35	0.97
38. I eat a good meal before using drugs at an event	5.12	1.18	4.30	1.03
39. I hydrate before using drugs at an event	5.44	0.97	4.44	0.98
40. I cultivate a positive mindset before using drugs at an event	5.24	1.15	4.50	0.85
41. I ensure my phone is fully charged before attending an event	5.10	1.26	4.27	1.06
42. When using a new substance for the first time, I try it at home before using it at an event	4.41	1.61	4.10	1.05
43. I avoid consuming if I am sad, depressed, or if I am going through a rough patch	4.58	1.56	4.00	1.19
44. I check in with myself while using drugs to see how I am feeling	5.14	1.12	4.29	0.99
45. I seek out medical attention if I feel that I need it	5.10	1.48	4.37	0.98
46. If I am in a crowd and I start to feel overheated, I leave the crowd and take a break.	5.26	1.11	4.46	0.84
47. I take breaks and rest periodically to avoid overexertion and exhaustion	5.05	1.20	4.26	1.06
48. Before using drugs at an event, I familiarize myself with the location of medical stations and/or harm reduction services	4.29	1.66	3.86	1.26
49. Before using drugs at an event, I familiarize myself with the location of food and water stations	5.00	1.38	4.25	1.07
50. Before using drugs at an event, I familiarize myself with the location of exits	4.87	1.36	4.07	1.20

Study 1. Table 5. Quasi-Poisson and Gamma Model Results

	β	IRR	RR	SE	p
Quasi-Poisson Model					
Model 1					
PBS use frequency	-0.219	0.80	---	0.078	**.005**
Past year drug use	0.032	1.03	---	0.018	.082
Model 2					
Perceived PBS effectiveness	-0.254	0.78	---	0.090	**.005**
Past year drug use	0.029	1.03	---	0.018	.103
Criterion: Total past-year consequences					
Gamma Model					
Model 1					
PBS use frequency	-0.125	---	0.88	0.036	**< 0.001**
Past year drug use	0.016	---	1.02	0.008	**.045**
Model 2					
Perceived PBS effectiveness	-0.148	---	0.86	0.042	**<.001**
Past year drug use	0.016	---	1.02	0.008	**.047**
Criterion: Frequency of past-year consequences					

Study 2. Table 1. Respondent Characteristics

Characteristics	N	%	M	SD	Min	Max
Age			28.19	5.56	18	65
Gender						
Agender	3	1.4				
Gender fluid	9	4.0				
Gender queer	3	1.4				
Gender questioning	1	0.5				
Man	110	49.5				
Woman	91	40.1				
Non-binary	4	1.8				
Prefer not to answer	1	0.5				
Transgender						
Yes	5	2.2				
No	215	96.4				
Prefer not to answer	3	1.3				
Ethnicity						
Arab, Middle Eastern, or North African	15	6.6				
Asian or Asian American	19	8.4				
Black or African American	10	4.4				
Hispanic or Latino	25	11.0				
Native American or Alaska Native	8	3.5				
Native Hawaiian or Other Pacific Islander	3	1.3				
White or European American	144	63.4				
Not listed	6	2.6				
Race						
Asian	11	4.8				
Black	8	3.5				
Indigenous, Aboriginal, or First Nations	3	1.3				
Latino or Hispanic	27	11.9				
Middle Eastern	7	3.1				
White	177	78.0				
Not listed	2	0.9				
Sexual Orientation						
Straight or heterosexual	133	58.6				
Lesbian	3	1.3				
Gay	5	2.2				
Bisexual	52	22.9				
Pansexual	22	9.7				
Sexually fluid	10	4.4				
Queer	10	4.4				
Demisexual	8	3.5				
Asexual	2	0.9				
Questioning	4	1.8				

Study 2. Table 1. Respondent Characteristics Continued

Characteristics	N	%	M	SD	Min	Max
I use a different term	1	0.4				
Prefer not to answer	6	2.6				
Education						
Less than high school	2	0.9				
High school diploma or GED	32	14.7				
Some college	49	22.5				
Associates degree or technical certification	17	7.8				
Bachelor's degree	94	43.1				
Master's degree	19	8.7				
Doctoral degree	5	2.3				
Household Income						
$0-$9,999/yr	12	5.5				
$10,000-$19,999/yr	14	6.4				
$20,000-$29,999/yr	23	10.5				
$30,000-$39,999/yr	30	13.6				
$40,000-49,999/yr	29	13.2				
$50,000-$59,999/yr	29	13.2				
Over $60,000/yr	83	37.7				

Note. M, mean. SD, standard deviation

Study 2. Table 2. Drug Use Patterns

Drugs endorsed	Lifetime		Past year		Day 1		Day 2		Day 3		Day 4	
	N	%	N	%	N	%	N	%	N	%	N	%
No use	0	0	0	0	45	19.8	37	16.3	35	15.4	29	12.8
Tobacco/nicotine	189	83.3	171	75.3	115	50.7	127	55.9	126	55.5	116	51.1
Alcohol	219	96.5	206	90.7	138	60.8	155	68.3	145	63.9	122	53.7
Cannabis	221	97.4	206	90.7	138	60.8	155	68.3	151	66.5	142	62.6
MDMA	212	93.4	175	77.1	34	15	77	33.9	106	46.7	38	16.7
LSD	212	93.4	161	70.9	27	11.9	46	20.3	91	40.1	24	10.6
Cocaine	192	84.6	144	63.4	55	24.2	62	27.3	61	26.9	48	21.1
Psilocybin	212	93.4	172	75.8	56	24.7	87	38.3	72	31.7	54	23.8
DMT	158	69.6	87	38.3	11	4.8	21	9.3	32	14.1	20	8.8
Peyote/mescaline	29	12.8	11	4.8	3	1.3	2	0.9	2	0.9	2	0.9
2C series	43	18.9	18	7.9	3	1.3	2	0.9	5	2.2	2	0.9
Ketamine	173	76.2	138	60.8	59	36.6	83	36.6	88	38.8	66	29.1
Nitrous oxide	156	68.7	107	47.1	50	22	55	24.2	55	24.2	41	18.1
Poppers	54	23.8	30	13.8	2	0.9	2	0.9	2	0.9	2	0.9
GHB	22	9.7	4	1.8	2	0.9	2	0.9	3	1.3	2	0.9
Kratom	83	36.4	36	15.9	5	2.2	6	2.6	6	2.6	6	2.6
Kava	65	28.6	28	12.3	3	1.3	3	1.3	4	1.8	3	1.3
Heroin	20	8.8	6	2.6	2	0.9	2	0.9	2	0.9	2	0.9
Fentanyl	15	6.6	8	3.5	2	0.9	2	0.9	2	0.9	2	0.9
Meth	40	17.6	12	5.3	3	1.3	3	1.3	3	1.3	3	1.3
Prescription pain killers	75	33.0	14	6.2	2	0.9	3	1.3	2	0.9	2	0.9
Prescription stimulants	117	51.5	62	27.3	12	5.3	15	6.6	14	6.2	12	5.3
Prescription anti-anxiety	97	42.7	31	13.7	6	2.6	11	4.8	10	4.4	9	4.0

Study 2. Table 3. Reagent Test Kit Use

Survey Item	N	%
Have you ever tested your drugs with reagents? Select all that apply.		
Yes, I have personally tested my drugs with reagents	123	54.2
Yes, a harm reduction organization has tested my drugs with reagents	16	7.0
Yes, a friend or family member has tested my drugs with reagents	58	25.6
Yes, a drug dealer has tested my drugs with reagents	52	22.9
Yes, an entity not listed here has tested my drugs with reagents	2	0.9
No, I have never tested my drugs with reagents	56	24.7
Which drugs have you tested before with reagents?		
MDMA/Ecstasy/Molly	140	61.7
LSD	41	18.1
Cocaine	111	48.9
Psilocybin	12	5.3
DMT	9	4.0
Peyote/mescaline	2	0.9
2C series	9	4.0
Ketamine	84	37
GHB	1	0.4
Heroin	2	0.9
Fentanyl	7	3.1
Methamphetamine	8	3.5
Prescription pain killers	4	1.8
Prescription stimulants	4	1.8
Prescription anti-anxiety	6	2.6
How often do you ensure your drugs are reagent tested prior to consumption?		
Never	9	5.3
Sometimes	50	29.6
About half the time	18	10.7
Most of the time	46	27.2
Always	46	27.2
When using reagents, have you ever found that your drug sample tested differently than you were expecting?		
No	95	55.6
Yes	76	44.4
After using reagents, have you ever consumed a drug that did not test as expected?		
No	45	60.8
Yes	29	39.2

Study 2. Table 4. Fentanyl Test Strip Use

Survey Item	N	%
Have you ever tested your drugs with fentanyl test strips? Select all that apply.		
Yes, I have personally tested my drugs with fentanyl test strips	115	50.7
Yes, a harm reduction organization has tested my drugs with fentanyl test strips	15	6.6
Yes, a friend or family member has tested my drugs with fentanyl test strips	31	13.7
Yes, a drug dealer has tested my drugs with fentanyl test strips	21	9.3
Yes, an entity not listed here has tested my drugs with fentanyl test strips	1	0.4
No, I have never tested my drugs with fentanyl test strips	76	33.5
Which drugs have you tested before with fentanyl test strips?		
MDMA/Ecstasy/Molly	110	48.5
LSD	8	3.5
Cocaine	97	42.7
Psilocybin	6	2.6
DMT	10	4.4
Peyote/mescaline	1	0.4
2C series	3	1.3
Ketamine	65	28.6
GHB	1	0.4
Heroin	2	0.9
Methamphetamine	2	0.9
Prescription pain killers	5	2.2
Prescription stimulants	4	1.8
Prescription anti-anxiety	9	4.0
Cannabis	1	0.4
How often do you ensure your drugs are fentanyl tested prior to consumption?		
Never	7	4.7
Sometimes	45	30.0
About half the time	9	6.0
Most of the time	43	28.7
Always	46	30.7
Have your drugs ever tested positive for the presence of fentanyl?		
No	117	78.0
Yes	33	22.0
Which of the following drugs have you had test positive for fentanyl?		
MDMA/Ecstasy/Molly	17	7.5
LSD	1	0.4
Cocaine	13	5.7
Psilocybin	0	0
DMT	0	0
Peyote/mescaline	1	0.4
2C series	1	0.4
Ketamine	7	3.1
GHB	0	0
Heroin	2	0.9

Methamphetamine	2	0.9
Prescription pain killers	4	1.8
Prescription stimulants	3	1.3
Prescription anti-anxiety	2	0.9
Cannabis	1	0.4
Have you ever consumed a drug after it tested positive for fentanyl?		
No	29	87.9
Yes	4	12.1

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