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Safety strategies and harm reduction for methamphetamine users in the era of fentanyl contamination: A qualitative analysis

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Abstract

Introduction: In the United States, methamphetamine use is increasing and the context of its use has changed, with reports of illicitly manufactured fentanyl being mixed with methamphetamine (either deliberately or inadvertently). We explore risk-mitigating actions taken by people who use drugs to protect their health when using methamphetamine in that context.

Methods: We conducted qualitative interviews with 48 adults (18+) who used methamphetamine in the past three months at two sites in Nevada, USA and two sites in New Mexico, USA. Interviews were recorded, transcribed, and analyzed using thematic analysis.

Results: Respondents described two rationales for employing harm reduction strategies. First, to prevent harm from methamphetamine containing illicit fentanyl, and second, to maintain their general wellbeing while using methamphetamine. Regarding methamphetamine containing illicit fentanyl, our findings highlight how respondents employ primary strategies like buying from trusted sources and secondary strategies such as spotting and selective use of harm reduction tools (i.e., fentanyl test strips) to reduce risks. To maintain their general wellbeing, participants reduced their use of methamphetamine as reasonably as possible, and used other substances

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Ethics statement

The University of Nevada, Reno was the IRB of record for this study, and the University of New Mexico IRB participated in a Single IRB Agreement.

CRediT authorship contribution statement

Olufemi Erinoso: Conceptualization, Formal analysis, Writing – original draft, Writing – review & editing. **Robbie Daugherty:** Writing – review & editing, Visualization, Formal analysis, Data curation. **Mia R. Kirk:** Data curation, Formal analysis, Writing – review & editing. **Robert W. Harding:** Data curation, Formal analysis, Writing – review & editing. **Haley Etchart:** Formal analysis, Writing – review & editing. **Andres Reyes:** Formal analysis, Writing – review & editing. **Kimberly Page:** Conceptualization, Supervision, Writing – review & editing. **Phillip Fiuty:** Formal analysis, Writing – review & editing. **Karla D. Wagner:** Conceptualization, Supervision, Writing – review & editing.

Declaration of competing interest

All other authors have no conflict of interest.

Supplementary materials

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like marijuana and alcohol alongside methamphetamine to counter the unwanted side effects of methamphetamine (i.e., hallucinations and paranoia). Use of these harm reduction strategies varied within situational and social contexts, and respondents usually developed these strategies based on their lived experiences.

Conclusion: Our findings uniquely demonstrate that people who use methamphetamine prioritize community driven, trust-based strategies within their social networks to mitigate risks in a fentanyl-contaminated drug environment. Additionally, our results indicate that harm reduction behaviors are influenced by multilevel risk environments, which include social, physical, economic, and political factors. Overall, these results highlight the potential for targeted interventions at the network level, which are responsive to complexities and shifts in drug market dynamics-such as illicit fentanyl in methamphetamine.

Keywords

Methamphetamine; Toxicity; Fentanyl; Opioids; Overdose; Qualitative methods; Harm reduction

Background

The US illicit drug market is undergoing significant changes with the emergence of illicitly manufactured fentanyl and increasing reports of fentanyl contained in or mixed with other drugs, including stimulants (Daniulaityte et al., 2023; Han et al., 2021; Hedegaard et al., 2021; LaRue et al., 2019; Shover et al., 2023). This trend reflects both the evolving nature of the drug supply and a longstanding practice of deliberately mixing stimulants with highly potent opioids (Krausz et al., 2021; Shukla et al., 2012), and necessitates updated strategies for prevention, education, and treatment to address this complex and evolving challenge.

Historically methamphetamine use has been concentrated in the western US (Durell et al., 2008; Iritani et al., 2007; Jones et al., 2022), and states like Nevada and New Mexico have had long standing issues with these drugs (Harding et al., 2022; Rhed et al., 2022). In recent years, the pattern of use and behavioral contexts surrounding methamphetamine use in the US has changed (Horyniak et al., 2015; Jones et al., 2022). Not only has methamphetamine availability become more geographically widespread (with increases in use documented in eastern states that historically had low prevalence), but as the opioid market has evolved, there are now reports of both intentional and unintentional co-use of illicitly manufactured fentanyl and methamphetamine (Daniulaityte et al., 2023, 2022; Jones et al., 2022; Lopez et al., 2021; Silverstein et al., 2021). Laboratory drug checking services have also confirmed the presence of fentanyl in methamphetamine supplies, with geographic variation that suggests the need for localized data and targeted response efforts (Jones et al., 2022; *NFLIS-drug special report: methamphetamine reported in NFLIS, 2001–2017*, 2019; Wagner et al., 2023). Despite these changes to the drug landscape, naloxone cascade studies have shown that people who use methamphetamine are less likely to know about or have naloxone (Lipira et al., 2021). Therefore, data from the western US about how people who use methamphetamine are navigating risk related to illicit fentanyl may have broader applicability to other regions where these drugs are expanding.

Public health harm reduction interventions, such as syringe service programs, linkages to substance use disorder treatment, overdose prevention centers, distribution of naloxone and drug test strips, and community-based drug checking, have been implemented to address drug use-related harms (Islam et al., 2008; Jones, 2019; Jones et al., 2022; Peiper et al., 2019; Shoptaw et al., 2006; Strike & Miskovic, 2018). These interventions address components of the drug risk environment—spaces where social or physical factors converge to elevate risks (Rhodes, 2002, 2009). This perspective informs our inquiry into how interactions between individuals who use methamphetamine and their physical and social environments inform their use of harm reduction strategies aiming to reduce methamphetamine- and fentanyl-related harms in two states (Nevada and New Mexico) where methamphetamine use is (and historically has been) prevalent and fentanyl has emerged in the past few years.

Fundamental to harm reduction approaches is an acknowledgment that people are the experts of their own experience, and using a patient-centered approach with community support can help develop interventions that are acceptable and practical for the people who use them (Harding et al., 2022; Krawczyk et al., 2022; Lambdin et al., 2023). Several studies have also confirmed that people who use drugs are aware of the potential harms that can result from drug use (Daniulaityte et al., 2022; Harding et al., 2022; Jones et al., 2022; Jones & Coffin, 2002; LaForge et al., 2022; Lopez et al., 2021), and employ safety measures to manage those risks (Abadie, 2023; Mars et al., 2018; Mistler et al., 2021; Walters et al., 2023), with strategies embedded within specific social and structural contexts. While these safety strategies have been relatively well documented in relation to HIV and opioids (specifically heroin and fentanyl) (Frank et al., 2023; Kesich et al., 2023; Wagner et al., 2010), understanding these dynamics in the context of expanding methamphetamine use and potential for fentanyl adulteration of methamphetamine is crucial. It offers the potential to refine and implement targeted, people-centered interventions responsive to the nuanced needs of those at risk, thereby enhancing the efficacy of harm reduction strategies and promoting overall public health.

In the current study, we explore the actions taken by people who use methamphetamine to reduce risk and ensure safety when consuming methamphetamine, especially in the context of potential fentanyl contamination. In addition, we examine the potential for a hierarchy of safety strategies, reflecting the varied risk environments faced by people who use methamphetamine. By applying the ‘risk environment framework’ (Rhodes, 2002), we aim to understand how these safety strategies interact with various individual and environmental contexts from the perspective of the people who use them. Several studies have used the risk environment to study harm reduction strategies among people who use stimulants, specifically among youth and women (McKenna, 2014; Russell et al., 2008). Shifts in the drug market, however, can influence the purity and price of drugs, affecting use patterns and related harms. The risk environment framework, allows us to consider these changes at various levels—such as how policy responses to drug markets (macro-level) impact access to harm reduction services or how individual and peer-network strategies (micro-level) adapt to market changes—enabling a more adaptive and responsive approach to harm reduction. Thus, by acknowledging the complexities of the risk environment, harm reduction efforts

can be more effectively designed to meet the needs of consumers and support the health and well-being of marginalized and criminalized populations (Rhodes et al., 2003).

Methods

Study design

The study was part of AMPED 2.0, a mixed methods study examining patterns of methamphetamine and opioid use among people who use drugs in the Mountain West. AMPED 2.0 consisted of a cross-sectional quantitative survey and semi-structured qualitative interviews. The quantitative survey covered the following topics: lifetime and past 3 months drug use, stressful and traumatic life events, experiences with overdoses, substance use disorder treatment, and drug mixing behaviors. Interviews were conducted February through July 2023 (Fig. 1).

Study setting

Our research took place in Nevada and New Mexico, two Western US states recognized for their notably high rates of illicit drug use, and drug markets characterized by high prevalence of stimulants, such as such as methamphetamine, cocaine, and opioids (Hernandez et al., 2021; Nevada Department of Health and Human Services, 2022; New Mexico Department of Health, 2021; SAMHSA, 2024). Specifically, in New Mexico, we recruited in Española and Albuquerque. Española, located in New Mexico's Rio Arriba County, has consistently had the highest drug overdose prevalence rates in the state (New Mexico Department of Health, 2021), and is also home to one of the country's longest operating harm reduction programs (Harm Reduction Program in New Mexico, 2024). In Nevada, we recruited from the two largest population centers: Reno, in the north and Las Vegas, in the south. Reno, situated in Nevada's Washoe County, has one of the highest drug overdose rates in Nevada (SAMHSA, 2024; Nevada Department of Health and Human Services, 2022).

Study sample

Participants for AMPED 2.0 were recruited from 1) Washoe County (Nevada), 2) Clark County (Nevada), 3) Española (New Mexico), and 4) Albuquerque (New Mexico). Recruitment was done by trained research assistants via word of mouth, flyers, and peer recruitment using incentivized participant referral (Heckathorn, 1997). To facilitate peer recruitment, participants were given the option to recruit up to three people they know who might qualify for the study; respondents were trained on select aspects of eligibility criteria and provided three referral coupons with unique codes to provide the person they referred. Referred participants must have provided this unique code in order to be considered a referral. Individuals who screened and were referred by other participants, but could not provide a unique coupon code at the time of screening or enrollment were counted as "word of mouth" recruitment. Eligible participants were consenting adults (18+) who reported any non-medical substance use (excluding only alcohol, tobacco, cannabis, or a combination of only those three) in the previous three months, and were fluent in Spanish and/or English. A total of 420 participants completed the survey.

A sub-sample of 48 participants from this initial survey of 420 were re-contacted to complete an in-depth qualitative interview. Sampling for the qualitative interview was determined by respondents' answers to a subset of survey questions that identified people with a broad range of experiences using methamphetamine. The subset of participants ($n = 48$) was selected to represent diversity of participants across gender, race, poly/mono substance use, and length of methamphetamine use (both long-time methamphetamine and those new to methamphetamine use).

Data collection and qualitative measures

Quantitative survey items used in this analysis included: duration of methamphetamine use, overdose history, drug mixing behavior, fentanyl test strip use, and demographics to describe the qualitative sample participants. A detailed description of the questions and response options on the survey can be found in supplementary Table I.

Qualitative interviews lasted 45–60 min, and engaged participants to discuss their experience of changes in the drug supply, harm reduction strategies employed, and motivations to use each harm reduction strategy. For example, “*So thinking about the things that you mentioned that you do to keep yourself safe, you say that you smoked it to see the quality. Why do you do that? Is there a specific thing that you're trying to prevent?*”. Interviewers used a semi-structured interview guide with open-ended questions with probes; interviews were audio-recorded on a digital recorder in a private room and transcribed verbatim. Participants who provided consent received a \$30 cash incentive.

Data analysis

The qualitative analysis used an inductive and thematic analysis approach (Hesse-Biber & Leavy, 2010), in which transcripts were coded and codes were grouped into themes exploring the ways participants reduce the health risk of drug use. First, the lead author read the transcripts and developed memos for emerging concepts. Then, the transcripts were re-read, and emerging concepts that aligned with the research questions were identified, highlighted, and coded. Similar codes were combined into themes, and some themes were combined to form broader themes. Two co-authors, who also participated in the data collection process, (RD and HE) reviewed the coding, and areas of disagreement were discussed with the larger team which comprised researchers and harm reduction service providers to reach a consensus. Participant descriptions are presented in the results in the following order- a respondent ID (i.e., R001), interview site (NV or NM), gender, age, race/ethnicity, length of methamphetamine (MA) use in years (i.e., used MA for 7 years).

Results

Participant demographics

We conducted interviews with 48 participants. Three people completed their interviews in two parts, resulting in a total of 51 separate interviews. Respondents were 45.8 % male, and a majority were non-Hispanic white (79.1 %). The median age was 38 years (Interquartile Range (IQR): 35–52) (Table 1).

Drug use and overdose history

The median duration of methamphetamine use was 15.5 years (IQR: 8–21 years), with a range of 1–39 years. A majority (64.6 %) used methamphetamine daily or almost daily in the past three months (Table 1). Two-thirds ($n = 31$, 64.6 %) reported deliberately mixing drugs in the past three months. Among those who mixed drugs, 96.8 % ($n = 30$) mixed methamphetamine with other drugs, including fentanyl ($n = 19$, 63.3 %), heroin ($n = 14$, 46.7 %), and alcohol ($n = 10$, 33.3 %) (Table 2). More than a third (39.6 %) had experienced an opioid overdose in their lifetime, while 6.3 % indicated they had overdosed on a combination of opioids and other stimulants in their lifetime and 29.2 % reported experiencing an episode of acute methamphetamine toxicity in their lifetime (i.e., “overamping”).

Safety strategies

In response to our research question “*what kind of things do you do to keep yourself safe when you use drugs [methamphetamine]*”, we identified two principal groups of strategies. The first was related to safety from harms linked to methamphetamine that might contain fentanyl and the risk of overdosing; the second was related to strategies to reduce the unwanted effects of methamphetamine on general wellbeing (Fig. 1).

Safety from harms related to overdose and methamphetamine containing fentanyl

Two-thirds of the respondents in this qualitative sub-sample reported deliberately mixing methamphetamine with other drugs, and most of those mixed it with opioids or alcohol (another CNS depressant), both of which can elevate overdose risk. Nonetheless, participants expressed concerns about using fentanyl inadvertently, as a result of unanticipated exposure via methamphetamine. As such, they described strategies to stay safe from accidental overdose from methamphetamine containing fentanyl, which they employed selectively, depending on the social and environmental context and the source of the drugs. Participants employed five distinct strategies in this domain (Fig. 1). We use “first line strategy” to refer to strategies respondents typically engaged in first, and “second line strategy” to refer to practices they engaged in when situational contexts did not allow for the strategies they typically depended on (i.e., their “first line strategy”).

1. First-line strategy: buy from a trusted source: A first line strategy mentioned by many participants to reduce the risk of accidental overdose or exposure to methamphetamine containing fentanyl was purchasing methamphetamine from people who they considered reliable sellers (mentioned by 21 people). This includes, as often as is practically possible, buying from and remaining consistent with a trusted source of methamphetamine. For example, participant R004 not only restricts her drug buying to known sources, but she also restricts her use to situations where she can avoid using with strangers:

“I try to stay with like certain people. I won’t buy it like on the streets or from people I don’t know. I won’t even smoke or do anything with people I don’t know.” And “I don’t do drugs that I don’t know where they’re from. That’s the only things that I really do to protect myself.” (R004, NV, Female, 57y, non-Hispanic white, used MA for 35 years)

R004 continued describing part of the rationale for her caution, which was based on her experience of losing people in her social network to overdose: *“A lot of people I know have died, probably 27 in last year”*.

Some participants who mentioned this strategy also discussed their experience with fentanyl-contaminated methamphetamine supplies and how that previous experience made them more careful moving forward. For example:

“Respondent: Probably. Like if it was coming around like in the shit, you know. So, like, after I tested [urine test] positive with the fentanyl and the meth, I really just kind of watched. I’m not getting the shit from anybody. I just started really paying attention and keeping it like consistent with the same person. Yeah. Because you just don’t know.

Interviewer: So before that—

Respondent: Yeah, I just kind of did it. It was kind of more carefree about it, you know? And after that, I was just like “No. I’m gonna pay more attention.” (R011, NV, Female, 44y, non-Hispanic white, used MA for 11 years)

Sources came to be “trusted” through the development of an enduring relationship over time. For some, this was based on consistently getting the expected sensory effects after buying the methamphetamine from this source, while others indicated the seller belonged to their social network, which developed and maintained their trust. Below, R014 highlights recent changes in “this new drug market” that impact his ability to always buy from a trusted source:

“The people I’ve been picking up from for years, I trust them. I know them. We’re around the same people every day. But, it seems like **this new drug market**, it’s a lot of people that just came up overnight that you met somebody and gave them a substantial amount of drugs to sell. **Nobody knows these people**, and they don’t know the people they’re selling to, so it seems like they don’t care if they give somebody fake shit, knowingly give them something fake that might kill them.” (R014, NV, male, 31y, non-Hispanic white, used MA for 14 years)

Overall, buying from a trusted source was a first-line strategy for many participants. When people were unable to do so, they resorted to second-line strategies such as using fentanyl test strips or sampling the drugs before use, described below.

2. Second-line strategy: Fentanyl test strips (FTS): The use of FTS was usually described as a second line strategy because participants mentioned using this approach when they couldn’t use other strategies such as buying from a trusted source. For example, R043 stated he would usually buy from a trusted source, but if unsuccessful, and his partner (also a trusted source of methamphetamine) wasn’t available, then he would use FTS:

“I’ll stick around with the person I get them from – normally. But once in a blue moon, if my girl isn’t at home, or she’s high, and I might have to go to somebody else. And then I use ‘em [FTS] for sure because I never know what is in that and it’s gonna be suicide”. (R043, NM, Female, 30y, multiracial, used MA for 13 years)

While some participants reported proactively and consistently obtaining and using FTS as a way to identify methamphetamine containing fentanyl, others used FTS occasionally based on availability with no mention of deliberate effort to seek them out. Just over one-third of the respondents in this qualitative sample reported ever using FTS. Of these 11 people, eight used them rarely, and three used them always. Four of the 11 who use FTS said they use them to make sure that drugs DO have fentanyl in them (i.e., to confirm the presence of fentanyl), while eight said they use them to make sure drugs DO NOT have fentanyl in them (i.e., to rule out the presence of fentanyl). Five participants who had not used FTS before the quantitative survey went on to use them after (prior to their qualitative interviews), and described that experience in their qualitative follow-up interviews. For example, participant R005 used the FTS he received after the quantitative survey and provided the context and reasons for using them:

“Actually, those test strips I got from you guys last time I was here, I’ve been using them now and then ... I test it before I smoke. I just put a little bit like I was told to. I’ll go test it. If it comes out cool, I’ll smoke. If not, then I’ll call the person back up and tell them off. I’m like, what the hell did you do? It’s not funny.” (R005, NV, Male, 38y, Hispanic, used MA for 20 years)

In terms of FTS availability, many respondents said they had access to FTS through harm reduction programs or other service providers [“I have the fentanyl test strips too. That’s really all that I do ... at the methadone clinic, they give us fentanyl test strips for free” R011, NV, Female, 44y, used MA for 24 years], and others indicating they obtain FTS from their peer-network:

“I definitely check my product every time I get it because they have the fentanyl test strips now. My friend ordered a couple of those, and she gave me some, so I would test that because I’m really, really scared with that stuff.” (R016, NV, Female, 35y, non-Hispanic white, used MA for 19 years)

Although most respondents indicated availability and willingness to use FTS, they commonly emphasized that FTS results were not completely reliable, possibly explaining why FTS was noted mostly as a second line strategy:

“We’ve got test strips that we get from different places. Sometimes those are faulty though”. (R004, NV, Female, 57y, non-Hispanic white, used MA for 35 years)

“Ummm, [the local harm reduction service], they have this um, what do you call them? Fentanyl test strips. Which um, I heard that they don’t really work right, that they’re not accurate. Yeah, but even at that, even at that, I still ... I ask them for the test strips”. (R046, NV, Male, 37y, non-Hispanic white, used MA for 20 years)

Despite these concerns, some participants described ongoing motivation to continue using FTS. Below, R027, who had an overdose on fentanyl (not mixed with methamphetamine) in the past, described using FTS to check for fentanyl in his methamphetamine, and responded by reducing the quantity he used when the test was positive.

“I really like them [FTS]. They are really easy to use, very knowledgeable and very informational on how to use them and how to test your dope [MA], and I like how you don’t have to use a lot to test your dope, you just use a little bit. So, you don’t

have to waste a lot of your dope [MA] to test it. But it's good to know because I was able to allow myself to not do as much so I don't OD, to know that fentanyl was in there. Because knowing the fentanyl was in there, I've got to respect it. So, I did a lot less, so I didn't die. But if I didn't know, I would have died like I did last time because I didn't know it was fentanyl." (R027, NM, Male, 37y, non-Hispanic white, used MA for 15 years).

How participants modified their use after positive results also differed. For example, participant R005 (quoted above) discussed testing his sample with the strips before smoking and how he would return the supply to the seller if it came out positive:

"I'll let my person, the one I got it from, I'll be like, 'hey, dude, you know this stuff has fatty [fentanyl]? This stuff's cut big time.' Either they'll know or act dumb about it and be like, oh, I don't know. Yeah, right. Or sometimes they'll be like, oh, shit, my bad, bring it back or throw it away. They've told me a few times, just toss it, that they don't want to mess with it. They'll get a hold of their people and then they'll go from there."

As the interview continued, R005 also described how he gives the seller FTS so they could test the entire batch for other people's safety.

Respondent: I'm like, uh-uh. I'm like, you better make sure your stuff doesn't have anything like that because I have test strips. I've even given my person, several of them, for their own safety and their own benefit, because they don't like that stuff.

Interviewer: Who do you give them to?

Respondent: My person I get the [MA] from.

Interviewer: You give them to...?

Respondent: I give a few of them to them then I keep the rest, just in case, because I don't want them to die either. I've known them for years. I know if it were to happen, it wouldn't be their fault, in a way, but at the same time yeah because they should know what they're selling or giving away or whatever. The test strips, yeah, they help a lot. (R005, NV, Male, 38y, Hispanic, used MA for 20 years)

This description points at the social dynamic between buyers and sellers, specifically when the seller belongs to the social network of the buyer there is an ethic of reciprocity and trust that can be leveraged to ensure mutual safety.

Other participants indicated that if they had methamphetamine that contained fentanyl, they would share it with members of their social network who normally would mix methamphetamine with fentanyl. For example, R025, who sells and uses methamphetamine, said she would share with members of her network who liked to mix both drugs, although she didn't do this personally. Again, this points to important social dynamics and ethics of reciprocity and community operating within drug using networks.

Interviewer: Okay. And when you've gotten meth that does have fentanyl in it, what do you do with it?

Respondent: I give it to people who want that and I tell ‘em it’s in there, that we tested it, it says it’s in there. Do you want it? Yes, they do want it. But those are for drug users that use both like I do. But like I said, I prefer to keep ‘em separate. I don’t wanna use them together. And there are people like me out there that prefer them separate and not together. (R025, NM, Female, 55y, Hispanic, used MA for 39 years)

As mentioned earlier, a third (33.3 %) of respondents in the study sample only used FTS intermittently. The qualitative data provide some information about the contexts that warranted such use. For example, some used FTS with a batch they suspected was contaminated, and others would use FTS when the physical appearance of the drug raised their suspicion. In other cases, respondents described barriers to consistent FTS use. For example, one respondent highlighted the barriers to consistent FTS use for individuals living without stable housing. Specifically, challenges related to moving frequently, having to transport weighty luggage, and finding secure and safe spaces to store one’s belongings without the risk of theft or arrest.

Interviewer: Yeah. What about fentanyl test strips?

Respondent: You could do that if you have room in your backpack to carry that along with your survival tools.

Interviewer: Right. If you have this, yeah. Okay.

Respondent: And have a cart to put ‘em in.

Interviewer: Okay.

Respondent: You figure it out, find a way to carry on your back.” (R002, NV, Male, 46y, non-Hispanic white, used MA for 30 years)

3. Second line strategy: Sampling and smoking: Of the forty-eight participants, thirty-one (65 %) talked about sampling their methamphetamine before using it as a protective measure against accidental fentanyl overdose. Sampling was primarily described using a sensory process, and was usually done when using methamphetamine with a group or with someone else.

Respondents described sampling using ‘indirect’ or ‘direct’ methods. When ‘indirect’, respondents described observing the effect of the methamphetamine on someone else before trying it themselves. For example, one respondent described a scenario where her seller invited her to use with a group. She believed that using FTS in this context might signal distrust, so instead she let someone else try it first. This underscores how social context and trust within networks confer benefits critical for promoting safety, but the potential consequences of violating social norms by signaling distrust is weighed against those benefits and sometimes found to be more important in the moment: (Wagner et al., 2010).

“Because sometimes, when I go to pick up from my connect, he’d be like, ‘oh, come in, let’s smoke,’ like a whole group thing. I don’t want to be the little annoying nerd. Like, ‘hold on, let me test it real quick [with FTS].’ I let them

smoke first and if they're okay, then I go." (R016, NV, Female, 35y, non-Hispanic white, used MA for 19 years)

On the other hand, others described smoking methamphetamine so they can detect sensory cues of fentanyl. Their rationale that smoking is easier to control and less likely to cause overdose than injecting. This transition to smoking methamphetamine is consistent with data from other US locations where fentanyl is more prevalent, where research has documented transitions from injecting fentanyl to smoking it (Kral et al., 2021). For example, R035 said:

“Respondent: The meth, if you smoke it, you can gauge it so you don't overdose, compared to snorting and injecting. You could overdose a lot easier like that because once it's in your blood and you inject it, it hits you right away, so it hits you a lot harder. Interviewer: Thinking about the things you just mentioned that you do to keep yourself safe, why do you do those things? What are you trying to prevent or to happen when you do them?”

Respondent: Well, obviously, you don't want to overdose, so gauge it.” (R035, NM, Male, 19y, multiracial, used MA for 1 year)

Respondent R002 describes how experiencing a yawn after smoking a sample of methamphetamine suggests to him that it contains fentanyl:

“I say you sample it before you. You kind of smoke with the person you buy it from... But when you take a hit of it, like I just smoke it, I don't slam it or do anything like that, but if you take a hit of it, and you blow it out, and you yawn immediately afterwards, it means there's fentanyl in it.” (R002, NV, Male, 46y, non-Hispanic white, used MA for 30 years)

While sampling the methamphetamine in the presence of the supplier worked as a strategy for some, others expressed skepticism about their ability to sample before buying because of the attitude of sellers:

“Interviewer: How do you check the quality of your meth before you use it?”

Respondent: That's tough. You really can't. You really can't check the quality because, somebody says, you try before you buy, but more than likely, that's not gonna happen.

Interviewer: How come that doesn't happen?

Respondent: Because people usually don't care. It's cheap enough for them to feel you're there to buy it and take a chance on it. If you don't like it, well, then that's on you. They don't care. They want to make their money, and they don't really care if – long-term, having a customer come back, keep coming back, most people that are making that quick buck, they don't really care.

Interviewer: Okay.

Respondent: They don't really care if you're checking. They don't care if you are happy or satisfied with the product, pretty much, unless it's somebody that you've been with for a long time, which is very rare.” (R017, NV, female, 33y, non-Hispanic white, used MA for 18 years)

R002, who described sampling with his buyer above, also described challenges with that approach. Specifically, sampling might not be practical when buying small quantities:

“But when all you have is— you know, you’re trying to just get a 10 sack or something just get by, then you don’t really have enough to—[sample].” (R002, NV, Male, 46y, non-Hispanic white, used MA for 30 years)

In most cases, when using with a group or when the source of methamphetamine was trusted, sampling was employed as a second line strategy. However, when the social context was less trusted, some people prioritized sampling as a first line strategy.

4. Second line strategy: Physical appearance—When some participants ($n = 7$) were unable to buy from a trusted source they reported inspecting the physical appearance of their methamphetamine to confirm purity. For example, one participant described how physical features, like color, suggest possible contamination with fentanyl: “*Any of the stuff I had that I suspected fentanyl in them had a bit of a milky, a bit of a yellowish tint.*” (R007, NV, Female, 56y, non-Hispanic white, used MA for 28 years) Another participant explicitly stated that if its powdery and not solid clear, then it has fentanyl in it: “*You can tell by the way it looks sometimes too, if it looks like it’s all powdery as opposed to just the solid, clear chunk.*” (R022, NM, non-binary, 31y, non-Hispanic white, used MA for 12 years) R002, quoted above, explained his response to methamphetamine that appeared suspicious: he removes the ‘off-color’ parts and uses the parts that appear uncontaminated (crystal appearance), then saves the ‘off-color’ parts for a rainy day (i.e., periods of dope-sickness) or gives it away after informing them that there might be fentanyl in it.

Conversely, other respondents described how they couldn’t tell purity by physical appearance, and expressed views that these days all methamphetamine is contaminated in some way or another: “*I mean, you’re not gonna find pure meth, period, unless you are the cook*” (R007, NV, Female, 56y, non-Hispanic white, used MA for 28 years).

5. Second line strategy: Spotting and Social support: Several respondents described ‘spotting’ as a strategy to protect themselves from the risk of overdosing on methamphetamine containing fentanyl. Spotting is an informal practice which entails supervision of drug consumption, typically by trusted members of the person’s social network (Perri et al., 2021). The references to spotting in this study usually entailed having friends around when using methamphetamine or having friends and roommates check on them at pre-determined time-intervals when using methamphetamine. For example:

“I’ll keep my door unlocked. That way, roommates, I’ll give my roommate a heads-up just in case, knock on there in ten minutes, just in case. But yeah, that’s about it.” (R014, NV, Male, 31y, non-Hispanic white, used MA for 16 years)

Similarly, when R018 was probed about how ‘spotting’ helped reduce risk of overdose, he stated: “To have a partner with me that’s there, for one, to keep an eye, make sure that if something does happen, they’ll be able to help me in any way possible and not to overdo it.” (R018, NV, Male, 35y, non-Hispanic white, used MA for 16 years) Another participant explained what that “help” might look like: having naloxone present even when only using methamphetamine:

“You don’t do it by yourself. You don’t do it by yourself. Always have someone with you. Always have Narcan with you. Even though you’re doing meth, it’s good to have Narcan for the fentanyl. That’s about the only thing you can do...” (R024, NM, Male, 39y, non-Hispanic white, used MA for 10 years)

Furthermore, some respondents explained that the availability of naloxone was an important factor in their strategies for preventing overdose from methamphetamine contaminated with illicit fentanyl, and provided the context surrounding the use of naloxone. This was the case for R014 and R048, where both indicated how they always had naloxone available and used it alongside ‘Spotting’ as a strategy to protect themselves from overdose.

“Normally, every time. If I’m at home, in my room, I always have Narcan. If my roommate’s not here, I can just tell my dealer, hey, this stuff seems a little strong. Call me in five minutes. If I don’t answer, you live pretty close to me, just come over. I’ll leave the door unlocked. It’s pretty easy to be saved every time. The only timing, I guess, would be hardest is if you’re homeless and out on the trail. It’s a little harder.” (R014, NV, Male, 31y, non-Hispanic white, used MA for 16 years)

“Given these conditions, what kinds of things do you do to keep yourself safe when you’re using drugs? R: Just do a portion of it, not take a whole lot of it, and keep Narcan close all the time, preferably.” (R048, NM, Female, 34y, non-Hispanic white, used MA for 2 years)

Safety from harms related to effects of methamphetamine (MA) on general wellbeing

In addition to strategies specific to reducing risk for inadvertent fentanyl exposure or overdose, participants also described strategies to reduce negative/unwanted side effects of methamphetamine use on their mental, physical and social wellbeing. Four strategies were identified: Reducing frequency of use; Using other substances to counteract effects of methamphetamine; Hydration and eating; and Using sterile equipment (Fig. 1).

1. Reducing frequency of use: Some participants described reducing their frequency of use as a strategy to reduce health harms related to methamphetamine use. Specifically, a participant described concerns about premature aging and cardiovascular stressors:

“So I am slowly weaning myself away from something that makes me feel bad. I don’t like when my heart is stressing up. The blood flow isn’t going through my body, and it makes my legs feel like really heavy. I guess I’m getting older, but I don’t want people to think that I’m 80 or 90 years old. I’m not. So, I don’t want to prematurely have myself in hospice or find myself immobile.” (R010, NV, Male, 57y, African American, used MA for 3 years)

R005, who recently experienced a heart attack, mentioned cutting back on his methamphetamine consumption as a result.

“Respondent: Yeah. I’ve pretty much like cut back dramatically on that.

Interviewer: Okay. What kind of spurred that?

Respondent: I had a heart attack.”

(R005, NV, Male, 38y, Hispanic, used MA for 20 years)

He went on to say he also changed from injecting to smoking, to reduce harm from methamphetamine use following the heart attack.

2. Use of other substances—In some cases, participants discussed how they used other drugs to counteract the unwanted effects of methamphetamine (e.g., anxiety, paranoia).

“I would say that I use other drugs. Like if I use too much clear [MA] and I get a little paranoid or I get a little nervous or whatever, I drink or I’ll smoke some weed [marijuana] to balance it out to keep me leveled. You know what I mean?” (R001, NV, Male, undisclosed race/ethnicity, 49y)

In other cases, the use of methamphetamine itself was described as a strategy to reduce risk for fentanyl overdose. For example, another participant with a long history of methamphetamine use described how he used methamphetamine to prevent fentanyl overdose:

Respondent: When I do fentanyl, I have to have methamphetamine in my system, otherwise I’ll go out [overdose].

Interviewer: Okay. So, you feel like the methamphetamine is protective for you against the fentanyl?

Respondent: Yes.

(R006, Male, NV, 45y, non-Hispanic white, used MA for 31 years)

The same participant indicated he had overdosed on opioids (without stimulants) in the past, and regularly (at least 1–4 times a week) used opioids combined with methamphetamine in the past three months.

3. Hydration and eating—Other strategies to reduce unwanted effects (e.g., delusions) of excessive methamphetamine use included basics such as hydration, nutrition, and sleep, “[stay] *hydrated, eating, and sleeping. You gotta sleep or else you end up like the people that are walking around talking to themselves.*” (R004, Female, NV, 57y, used MA for 35 years) When R004 was probed about the effects of methamphetamine use when she didn’t hydrate or eat properly, she described physical side-effects that affected her wellbeing negatively:

“Interviewer: Can you tell me the difference between when you’re using and you’re hydrated and eating, versus when you’re using and you’re not hydrated or eating?”

Respondent: I feel weaker. I feel like just falling asleep everywhere I go. The minute I sit down, I just feel like going to sleep.” (R004, Female, NV, 57y, non-Hispanic white, used MA for 35 years)

4. Using sterile equipment—Another strategy for general wellness was the use of sterile injection equipment, or what was described as a proper “set up,” to prevent blood borne pathogen exposure. For example, one participant described her precautions: “*Just make sure that I’m clean, one needle, one cooker, one everything, and I use all brand new*

each time, because I'm afraid of the hepatitis that people get and stuff like that.” (R032, NM, Female, 54y, non-Hispanic white, used MA for 20 years)

Another participant suggested a similar strategy with explicit reference to Hepatitis C virus transmission. *“I've always made sure to stay clean. I've never had Hep C or anything. Hygiene is really one of the biggest things you could do ...”.* (R035, NM, Male, 19y, multiracial, used MA for one year). These examples suggest knowledge within drug use communities about health risks linked with injection drug use, and how these strategies are adopted to mitigate specific risks.

Discussion

We explored the actions people who use methamphetamine use to keep themselves safe in an unregulated illicit drug risk environment where inadvertent exposure to fentanyl is increasing. While many of our participants deliberately consume methamphetamine and opioids (or other CNS depressants such as alcohol), they still expressed concern about inadvertent exposure, and employed behavioral responses such as buying from a trusted source and social responses like ‘spotting’ designed to guard against overdose due to unexpected exposure to fentanyl in methamphetamine.

The order in which these strategies were employed was influenced by aspects of the risk environment including the drug market, social networks and norms, and access to housing and harm reduction services. The most recurrent approach mentioned, and one that was typically trusted as a “first line” strategy, was buying from a trusted source – a socially embedded strategy of relying on the ethics of mutual trust and caretaking within networks of users and sellers that is common in drug-using circles. Some respondents even described taking the fentanyl-positive methamphetamine back to their dealers to warn them, so they could share that information with others. Other studies have described this approach as a response to growing concerns about fentanyl in other opioids and stimulants (Walters et al., 2023). Buying from trusted sellers also underscores the critical role of trust within social-networks in the drug use community (LaForge et al., 2022; Walters et al., 2023). Social network studies have explored peer-to-peer relationships and identified potential intervention points in the nodes within these networks (Bouchard et al., 2018; Chang et al., 2021). These network nodes could be used to distribute harm reduction information and supplies, which could increase acceptability and access. However, the instability that characterizes the community, as well as the criminalization of drug sellers, presents a significant barrier to these opportunities (Carrillo Beck et al., 2022; Das-Douglas et al., 2008; McKetin et al., 2020). Specifically, arrest and incarceration of low-level dealers can disrupt trusted networks and put consumers at more risk of purchasing from untested suppliers (Carroll et al., 2020).

In addition, despite broad public health messages encouraging naloxone use and drug testing, and fairly widespread access (in our settings)(*Harm Reduction Program in New Mexico; Nevada State Opioid Response*), to naloxone and FTS, our participants revealed that they deploy these strategies selectively. For some, it depended on social context and the potential harms associated with violating trust or community norms by employing test strips in an environment where such strategies could signal distrust. For others, it was more about

whether test strips were there in the moment they needed them or not. Although people who use stimulants are learning about opioid overdose prevention, access to harm reduction supplies is still not universal, particularly among people who use methamphetamine (Lipira et al., 2021), who have not historically been the target audience for opioid overdose education and prevention interventions. Thus, designing interventions to focus on safety strategies that help people learn how to negotiate safer use, navigate social barriers, and stay safe in various risk environments may strengthen positive adaptive behaviors.

Almost half of the respondents mentioned using the physical appearance (sight and color) and sensory (smell, taste, sensory effects, etc.) characteristics of methamphetamine to ascertain safety (and purity). Our finding is consistent with prior research in which people reported relying on the feel, taste, smell, or appearance to determine fentanyl's presence in other drugs (Daniulaityte et al., 2019; LaForge et al., 2022; Watson et al., 2023). A recent study also found that the prevalence of fentanyl in methamphetamine was more than 11 times higher for powdered vs. crystalline forms of the drug (Wagner et al., 2023), which suggests that there might be some validity to this strategy in some drug markets. In the absence of point-of-care drug checking or the ability to rely upon a trusted source, people resort to less accurate diagnostics such as physical and sensory characteristics of substances to determine their safety. Participants in our study also described informal social drug testing systems, whereby if they confirmed their methamphetamine contained fentanyl, they would inform the seller and members of their social network, demonstrating micro-environment responses to peer group risks.

Further, respondents used spotting as a form of social support to mitigate the risk of overdose. "Spotting" is a practice among people who use drugs, where individuals observe others using drugs, either within or outside their social network, to respond in case of an overdose. This practice was developed by people who use opioids as a way to prevent opioid overdose and is now a commonly recommended opioid overdose strategy (Perri et al., 2021). Our findings suggest spotting is also being taken up as a safety strategy for using methamphetamine, indicating diffusion of harm reduction techniques typically employed by people who use opioids into other groups. These examples again highlight the critical role of social support and trusted network members in ensuring community safety – people expressed confidence that their peers would look out for each other (Mercer et al., 2021; Moore, 2004). Spotting was used alongside other opioid-focused harm reduction interventions, like naloxone administration, suggesting an ongoing need to ensure widespread naloxone distribution to those most likely to be at the scene, even when people are using methamphetamine. Again, these findings align with prior studies (Islam et al., 2008; Peiper et al., 2019; Perri et al., 2021; Reed, Guth et al., 2022; Reed, Salcedo et al., 2022; Strike & Miskovic, 2018), and suggest acceptance of conventional opioid overdose prevention strategies even among people who mostly use stimulants. A logical next step might be to increase access to naloxone and FTS and target distribution to areas where methamphetamine use is common, especially using mobile harm reduction services and vending machines in high-risk areas (e.g., outside correctional facilities and recreational parks) so those who face barriers to accessing traditional brick-and-mortar services can also have access (Islam & Conigrave, 2007; Islam et al., 2008; Strike & Miskovic, 2018). Another structural intervention that could consolidate many of the first and

second line strategies discussed by our respondents is the implementation of supervised drug consumption sites. Supervised drug consumption sites, also known as overdose prevention centers, are evidence-based interventions (Caulkins et al., 2019; Kennedy et al., 2017; Potier et al., 2014) that provide access to on-site medical care and peer support in the event of an accidental overdose, and can also provide sterile drug use supplies, reliable access to FTS and other drug checking services, and bridge connections with the health care system. By integrating these services, supervised drug consumption sites can holistically address the complex risks associated with the drug risk environment, and support the development of informed and community-driven responses to drug safety within peer networks.

The role of educational interventions is also critical to the harm reduction toolbox (Ghasemi et al., 2014; Jeal et al., 2015; Kennedy et al., 2022). Prior studies have shown how some people hold potentially harmful beliefs, such as mixing fentanyl with methamphetamine to counter the unwanted effect of one with the other (Daniulaityte et al., 2019, 2023, 2022; Silverstein et al., 2021). While these techniques may provide sensory and behavioral benefits, especially for withdrawal symptoms, these strategies may also increase the risk of toxicity and exposure to unknown substances. Therefore, community-driven and patient-centered approaches to education might be one way to counter these potentially harmful beliefs and practices. In addition, our findings underscore the need for more proactive educational campaigns focused on general wellbeing, rather than solely reducing overdose risk. Specifically, some respondents reported a link between methamphetamine use and health concerns (i.e., heart attack), reflecting emerging evidence that the accumulation of cardiovascular harms is a serious concern among people who use methamphetamine. Thus, robust interventions focused on cardiovascular outcomes rather than solely abstinence are warranted (Riley et al., 2022).

Our study has several limitations. First, we drew our sample from sites with high rates of illicit drug use and drug-related deaths in the US, including historically high opioid and methamphetamine consumption and emerging (but not yet saturated) fentanyl markets. Thus, social contexts and norms might differ in other states, especially where methamphetamine is newer or fentanyl is more entrenched, limiting the transferability of our findings to those settings. Second, based on our sampling method, our initial seeds could have introduced some form of bias. However, we ensured diversity and representativeness in the initial seeds of respondents to minimize bias throughout our sampling process. Further, purposive sampling from the quantitative sample for qualitative interviews helped select individuals with diverse backgrounds and characteristics necessary for the research question in the study. We believe it is important to highlight that a significant majority of participants in this study were long-term methamphetamine users, with a median duration of use being 15.5 years (IQR of 8–21 years). Consequently, our results reflect the characteristics and adaptations of individuals with prolonged methamphetamine use, rather than those who are in the early or experimental phases of drug use.

Conclusion

In conclusion, our study identified the ways in which people who use methamphetamine prioritize and employ harm reduction strategies in response to shifts in drug market

dynamics- such as illicit fentanyl in methamphetamine supplies. These results show that harm reduction practices are shaped by the multilevel risk environments encompassing social (i.e., peer-networks), physical (i.e., resource availability), economic (i.e., financial need, housing instability), and political dimensions (i.e., law enforcement). Furthermore, these findings emphasize the critical role of social networks and community-driven efforts to mitigate drug related harms in an uncertain and dangerous illicit drug environment.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Data availability

Because of the sensitive nature of the information contained in the transcripts (e.g., details about illegal behavior) and potential for severe ethical, legal, and social consequences resulting from broken confidentiality, full transcripts will not be made publicly available. Redacted excerpts of the qualitative transcripts used in the current analysis will be made available to qualified researchers subject to review and approval by the appropriate Institutional Review Board(s). Requests can be made to the University of Nevada, Reno Research Integrity Office by calling +1-775-327-2368.

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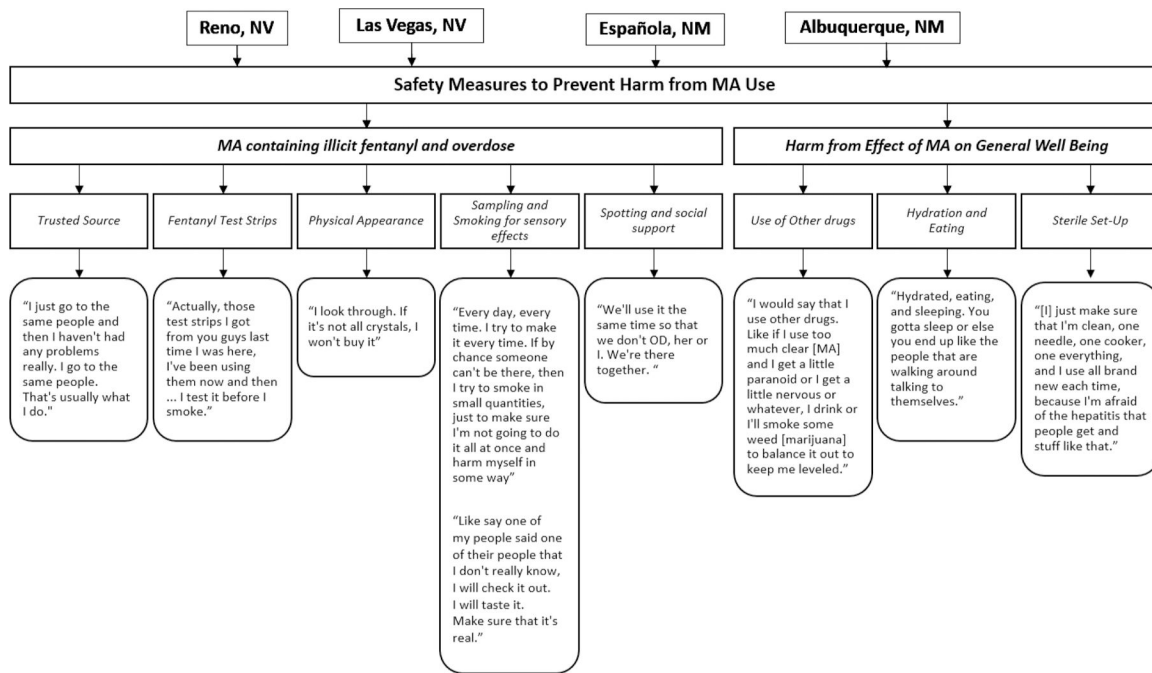


Fig. 1. Themes and subthemes of safety measures to prevent harm of Methamphetamine (MA) use.

Table 1

Descriptive summary of participant characteristics.

Variables	N = 48 n (%)
Median Age (IQR)	38 [35.0–51.5]
Gender	
Female	22 (45.8)
Male	22 (45.8)
Other	4 (8.4)
Race/Ethnicity	
Non-Hispanic White	38 (79.1)
Non-Hispanic Black/ African American	2 (4.2)
Hispanic	2 (4.2)
American Indian/ Alaskan Native	1 (2.1)
Multi-racial	4 (8.3)
No response	1 (2.1)
Median duration of methamphetamine use (IQR)	15.5 [8–21]
Frequency of methamphetamine use in past 3 months	
Never	2 (4.2)
Daily or almost daily	31 (64.6)
Weekly	8 (16.7)
Monthly	3 (6.2)
Less than monthly	4 (8.3)
Overdose history	
OD on Opioids	
No	25 (52.1)
Yes	19 (39.6)
No response	4 (8.3)
OD on Opioids and other substances	
No	40 (83.3)
Yes	3 (6.3)
No response	5 (10.4)
Ever experienced acute methamphetamine toxicity	
No	34 (70.8)
Yes	14 (29.2)

Notes: *IQR: Interquartile range. OD- overdose. The measure “ever experienced acute methamphetamine toxicity” was assessed with the question: “Have you ever experienced effects that made you feel like you needed medical attention when using methamphetamine?”.

Table 2

Participants' drug use behaviors.

Variables	<i>n</i> (%)
^a Drug mixing in the past 3 months	<i>n</i> = 48
No	17 (35.4)
Yes	31 (64.6)
^b Methamphetamine mixing in the past 3 months	<i>n</i> = 31
Yes	30 (62.5)
No	1 (2.1)
^c Drugs mixed with methamphetamine in past 3 months	<i>n</i> = 30
Alcohol	10 (33.3)
Benzodiazepines	1 (3.3)
Cocaine	5 (16.7)
Fentanyl	19 (63.3)
Heroin	14 (46.7)
Prescription amphetamines	1 (3.3)
Prescription opioids	4 (13.3)
^d Other drugs	9 (30.0)

Notes:.

^aOne participant did not respond to the question prompt.

^b17 participants were skipped because only those who indicated 'Yes' to prior question about 'drug mixing' in past 3 months were prompted with the question about methamphetamine drug mixing.

^cThe 30 participants who indicated 'Yes' to prior question about 'drug mixing' in past 3 months were prompted with the question about drugs mixed. Denominator for each drug mixed was *n* = 30.

^d8 participants indicated marijuana only, one participant marijuana and crack, one participant marijuana and black, and another participant black only.