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Mechanisms of resilience and coping to intersectional HIV prevention and drug-use stigma among people who inject drugs in rural Appalachian Ohio

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Abstract

Background Intersectional stigma of drug-use and HIV hinders provision and utilization of HIV prevention services for people who inject drugs (PWID), particularly within rural US communities. Resilience and coping may be critical for PWID to counter pervasive stigma.

Methods Between October 2021 and July 2022, 35 in-depth interviews were conducted in Appalachian Ohio to understand the intersection of drug-use and HIV prevention stigma and how resilience and coping processes are displayed, shared, and enacted. Interviews were audio-recorded and transcribed verbatim. Thematic analysis was conducted, guided by Harper et al.'s four key resilience processes: (a) engaging in health-promoting cognitive processes, (b) enacting in health behavioral practices, (c) exchanging social support, and (d) empowering other PWID to engage in health behavior practices.

Results Resilience processes aligned with the Harper framework with additional coping processes identified, including anticipation strategies and maladaptive coping. Empowering other PWID emerged as a prominent resiliency process, often supported by systems of support like syringe service programs (SSPs), which provided resources and helped reduce stigma. However, bidirectional social support was constrained, as PWID frequently acted as providers of resources and referrals for peers despite limited knowledge of HIV prevention strategies and feeling unsupported themselves. Anticipation strategies were employed to manage anticipated stigma, including accessing support or, conversely, avoiding healthcare and refraining from disclosing drug use. Maladaptive coping included behaviors such as social isolation and self-administered medical care, highlighting critical gaps in opportunities to foster resilience.

Conclusions Findings highlight that empowering peers and anticipation strategies can be key resilience processes, while maladaptive coping and limited bidirectional social support underscore the need for resilience-building and stigma-reduction interventions. Tailored systems of support for PWID in rural communities are critical to fostering adaptive coping and enhancing engagement with HIV prevention services.

Keywords Stigma, Resilience, People who inject drugs, HIV

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Introduction

The opioid epidemic in Ohio has increased the risk for an HIV outbreak among people who inject drugs (PWID) [11, 49]. Injection drug-use-related HIV risk is concentrated within rural communities [3, 25, 34]. In Appalachian Ohio, Scioto, Pike, Jackson, Gallia, Meigs, and Vinton counties are among the top 5% of U.S. counties most vulnerable to an HIV outbreak [11]. HIV-vulnerable Appalachian counties will need evidence-based strategies to prevent an HIV outbreak. Harm reduction services, including syringe service programs (SSPs), are becoming more prevalent, but coverage of these HIV prevention strategies remains limited [11]. For example, over 50% of Appalachian PWID in Kentucky have never used an SSP [28]. Factors influencing SSP underuse are multifaceted but include perceived low HIV risk, fear of being seen by community members, and lack of awareness [2, 28].

Stigma is a complex social process where personal attributes or identities are met by social exclusion, rejection, blame, and discrimination [50]. For PWID, drug-use stigma is likely a major barrier to engaging in HIV prevention services [26]. For instance, PWID in rural Ohio often delay seeking healthcare due to shame and fear of discrimination from providers [39, 42, 44]. Similarly, HIV prevention stigma discourages engagement in testing and prevention services, driven by fears of discrimination, low self-worth, and apprehension about disclosure or ostracization from social networks [47, 51].

Intersectional theory emphasizes that socially devalued and oppressed identities—such as those tied to drug use and HIV prevention—interact within systems of power to shape experiences and outcomes [6, 7, 14–16, 20]. For PWID, the dynamic intersection of drug-use stigma with HIV prevention stigma amplifies healthcare barriers and increases HIV vulnerability, particularly in rural Appalachian communities where pervasive stigma and limited healthcare access exacerbate these challenges [4, 12, 26, 28, 36, 48]. These intersecting stigmas, rooted in broader social and structural contexts, complicate engagement with HIV prevention services, particularly in rural Appalachian communities where limited healthcare access and pervasive stigma intensify these barriers. While prior research has examined these dynamics among people living with HIV, little attention has been given to how they affect PWID at risk for HIV. Mitigating the negative effects of intersectional drug-use and HIV prevention stigma through evidence-based, tailored interventions is critical for enhancing HIV prevention engagement, fostering resilience, and improving outcomes among PWID in rural Appalachia.

PWID in rural Appalachian Ohio may develop mechanisms for enhancing resilience to detrimental impacts of stigmatizing events, that are specific to the Appalachian culture [10, 37, 45]. Resilience is a strength-based, dynamic framework in which a person can overcome negative effects of a traumatic experience, like stigma from drug-use or HIV status, through coping strategies that may ultimately improve health-seeking behaviors [17, 21, 23, 31]. The use of resilience-promoting strategies, such as coping, disrupt the pathway from stigma to healthcare avoidance [17, 21, 23, 31]. Among an intersectionally oppressed population of young gay and bisexual men living with HIV, four core promotive resilience processes were identified by Harper et al.: (1) engaging in health-promoting cognitive processes; (2) enacting healthy behavioral practices; (3) enlisting social support; and (4) empowering others [23]. While resilience is broadly defined as adaptive processes that enable individuals to navigate and overcome adversity, coping refers to the strategies employed to manage stress, which may be either adaptive (contributing to resilience) or maladaptive (potentially hindering resilience) [22, 30]. Harper et al.'s core resilience processes provides a useful foundation, it is also important to explore how resilience and coping mechanisms may differ among populations such as PWID, particularly within unique socio-economic and cultural contexts like Appalachia. Appalachia has a deep-rooted history of health disparities coupled with a unique socio-economic context which may drive different resilience mechanisms for PWID (Lancaster et al., 2018). Although parallels can be drawn between the resilience processes identified in young gay and bisexual men and those potentially applicable to PWID, the relevance and adaptation of these processes should not constrain the opportunity to identify unique, context-specific mechanisms for resilience among PWID. Interventions implemented among stigmatized populations have been effective in improving health service utilization [5, 9, 32, 43, 46]. However, few studies have specifically leveraged resilience frameworks for PWID [29, 41], and existing resilience literature on HIV does not fully account for the compounded effects of drug-use stigma within this population [29].

Our study aims to understand resilience and coping processes among PWID while also identifying unique resilience-promoting mechanisms specific to this population within the socio-economic and cultural context of rural Appalachia. We conducted in-depth interviews with PWID living in rural Appalachian Ohio to understand mechanisms of resilience and coping to intersectional drug-use and HIV prevention stigma among PWID in rural Ohio.

Methods

Setting and recruitment

This study was conducted in six rural Appalachian Ohio counties: Scioto, Pike, Jackson, Gallia, Meigs, and Vinton. Individuals were recruited using purposive sampling that sought variation on gender and HIV testing history. Specifically, participants were recruited at SSPs, health clinics, and resource centers in rural Ohio or had previously participated in the Ohio Opioid Project (UG3/UH3DA044822), which formed the foundation of the growing research infrastructure in Appalachia Ohio. Individuals aged 18 years or older, residing in one of these six Appalachia counties, who had never received an HIV test or, if tested, had not been diagnosed with HIV, and who used injection drugs within the two weeks of recruitment were eligible to participate. Eligible persons were consented prior to one-on-one in-depth qualitative interviews with trained study staff.

Qualitative methods are ideal for capturing the dynamic, context-specific, and relational processes of resilience. An in-depth qualitative interview (IDI) was used to investigate how drug-use and HIV prevention stigma intersect among PWID and how resilience and coping processes are displayed, shared, and enacted to counter intersectional stigma among PWID in rural Appalachian counties. Structured interview questions were informed by Harper et al.'s four key resilience processes: (a) engaging in health-promoting cognitive processes, (b) enacting in health behavioral practices, (c) exchanging social support, and (d) empowering other PWID to engage in health behavior practices [23]. Interviewers used probes to further understand each participant's individual experiences, such as types of support received and provided, approaches for self-acceptance, examples of living well, receiving routine HIV testing or on pre-exposure prophylaxis (PrEP), and strategies to provide encouragement to peers.

Data collection

Data were collected between October 2021 and July 2022 and interviews were conducted and audio-recorded remotely via HIPAA-compliant Zoom video calls. A brief screening instrument was first used to assess eligibility. If eligible, study staff verbally explained the consent process and IDI activities and obtained verbal consent. Enrollment continued until theoretical saturation was met. A total of 39 participants were invited for the IDI. All IDIs lasted roughly 1–2 hours, were completed in English, and were conducted by an experienced interviewer. Only the interviewer and the participant were present during the IDI interview session. A $25 electronic gift card incentive was provided to participants for completing the IDI. Of the 39 PWID invited to participate, 1 was not eligible and 3 did not consent to participate. The remaining 35 PWID were enrolled and completed IDIs. All interviews were audio-recorded, transcribed verbatim, and coded for analysis.

Data coding and analysis

Thematic analysis was used to identify, analyze, and interpret patterns within the interview data, following Braun and Clarke's established guidelines [8]. This approach allowed for a flexible yet systematic examination of how resilience and coping processes were displayed, shared, and enacted among PWID. The codebook was developed using both deductive and inductive approaches, reflecting Harper et al.'s [23] four resilience processes while remaining grounded in the data. Initial codes were generated through a line-by-line review of a subset of five transcripts [13], enabling a thorough and iterative exploration of emerging themes. These initial codes were reviewed by the study team, which included a Portsmouth city health department partner, and integrated with the deductively derived codes to create a comprehensive codebook with 25 unique codes (Table 1). Four codes (i.e., health-promoting cognitive and behavioral practices, seeking social support, and empowering other PWID) were deductively created based on Harper et al.'s resilience framework, while all other codes emerged through iterative engagement with the data.

Two study team members applied the preliminary code definitions to the subset of interviews described above.

Table 1 Subset of code families created using a combination of deductive and inductive approaches

Code families	Description
Perceived drug stigma	Experiences of perceived drug stigma in everyday and healthcare situations
Social support	Methods and types of social support received from friends and family, other PWID, systems and institutions, and other
Stigma resilience	Mechanisms participants used to combat stigma from drug-use and/or HIV prevention stigma
HIV experiences	Knowledge, perceptions, protective health behaviors, and other experiences with HIV and PrEP
Health care	Discussions about the healthcare decision process (e.g., when/how participants decide to seek healthcare) and barriers to accessing healthcare

Using an iterative process, initial code definitions were refined, and new codes created, resulting in the finalized codebook. Final codes were re-applied to this subset (14% of the dataset), achieving a Cohen's kappa of 0.81, indicating substantial agreement [35]. Had the initial Cohen's kappa been lower, we would have continued double-coding until an acceptable reliability score was achieved. To ensure representativeness, the subset of transcripts for double-coding was randomly selected. The finalized codes were then applied to all transcripts for thematic analysis.

Analyses focused on the mechanisms and impacts of stigma resilience for PWID. Analytical memos were used to explore connections between intra- and inter-personal resilience themes, as well as the convergence and divergence of data across participants. Responses were compared both within and across gender and HIV test frequency groups. N*VIVO 12.0 qualitative data analysis software was used to assist with data management and analysis. Additionally, reflexive discussions between and among coders, study team members, and community partners were held periodically throughout data collection, coding, and analysis phases to ensure rigor and alignment with the study's objectives.

The study protocol and research tools were approved by the Ohio State University Institutional Review Board.

Results

Sample characteristics

Over half of the participants were female (n = 20), aged 30–49 years (n = 22), and most resided in Scioto County (n = 22) (Table 2). Most participants identified themselves racially and ethnically as non-Hispanic white (n = 34). Among those who reported ever receiving an HIV test (n = 33, 94%), 63% were tested more than six months prior to participation. None of the participants self-reported PrEP use.

Resilience processes and the role of systems of support

These six resilience processes encompass strategies at both individual (intrapersonal) and group (interpersonal) levels (Fig. 1). Individual resilience was demonstrated through health-promoting behavioral and cognitive processes, enabling PWID to resist internalized stigmatization and gain agency over their healthcare and outcomes. However, some participants engaged in maladaptive coping strategies, such as avoidance, self-isolation, and delaying healthcare, which reflected the challenges they faced in navigating stigma and underscored missed opportunities for resilience-building. Group resilience emerged through interactions with other PWID, particularly in the form of empowerment and seeking social support. Anticipation strategies, the most complex resilience mechanisms reported, operated at both intrapersonal (e.g., self-administered healthcare) and interpersonal levels (e.g., recruiting emotional or instrumental support), with both health-promoting and health-demoting effects.

Systems of support, such as syringe service programs (SSPs), are not resilience processes themselves but play a critical role in facilitating resilience processes. SSPs supported a bidirectional relationship between the two reported resilience strategies: healthy behavioral

Table 2 Demographic and HIV testing characteristics of PWID from rural Appalachia who completed in-depth interviews

		Total		Males		Females	
		n = 35	%	n = 15	%	n = 20	%
Age	18–29	6	17	1	7	5	25
	30–49	22	63	8	53	14	70
	50+	7	20	6	40	1	5
Ohio County	Scioto	22	63	12	80	10	50
	Pike	0	0	0	0	0	0
	Jackson	1	3	0	0	1	5
	Gallia	10	29	3	20	7	35
	Meigs	1	3	0	0	1	5
	Vinton	1	3	0	0	1	5
Race	White	34	97	15	100	19	95
	Mixed Race	1	3	0	0	1	5
HIV testing status	Ever	33	94	14	93	19	95
	Never	2	6	1	7	1	5
Duration since last HIV test	< 6 months	11	31	5	33	6	30
	> 6 months	22	63	8	53	14	70

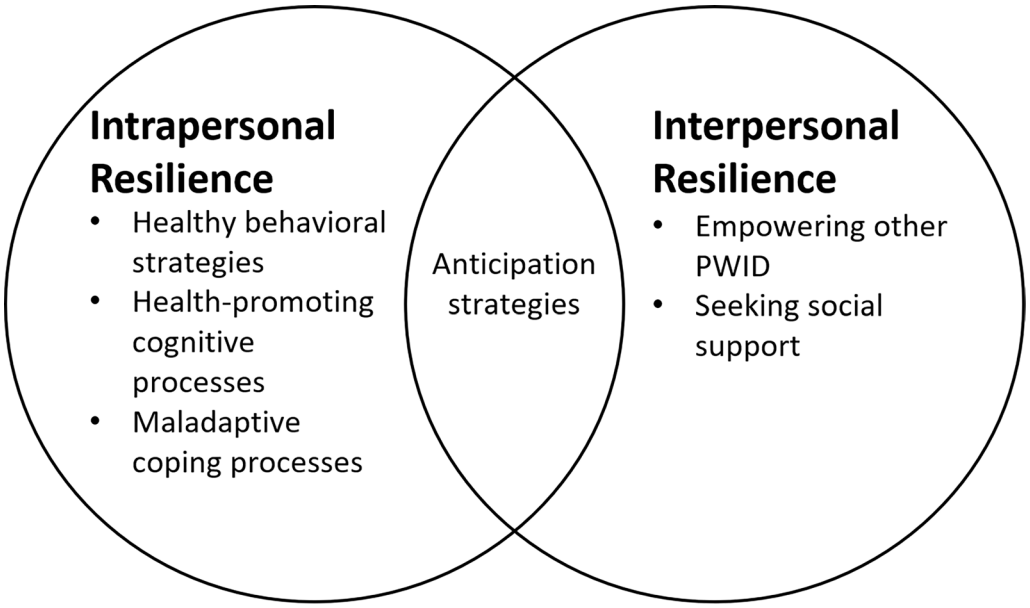

Fig. 1 Intra- and Interpersonal Resilience Processes Demonstrated by PWID in Rural Appalachian Ohio, Facilitated by Systems of Support

strategies and the empowerment of other PWID. By providing resources and support (e.g., sterile syringes, Narcan), SSPs enabled PWID to take responsibility for their healthcare while resisting internalized stigmatization. The autonomy fostered during SSP visits reinforced health-promoting behaviors and facilitated interpersonal empowerment through harm reduction education and the sharing of tangible resources.

One participant described overcoming her initial fear of SSPs, believing they were a "trick," but eventually deciding to access the program due to her urgent need for sterile syringes. She shared, "I was like man, screw it. I'm going out there [to the exchange] and see what happens. And you know, they ask for your name and stuff but, like I told my buddy, you can tell them your name is Santa Claus and they don't care. Like you just give them your initials, your used needles and whatever, and there you go [with Narcan and sterile injection supplies]. They don't care who you are, they're only there to help." This nonjudgmental support enabled her to inject safely, demonstrating the critical role of SSPs in facilitating resilience.

Engagement in healthy behavioral strategies

Engagement in healthy behavioral strategies emerged as a prominent form of intrapersonal resilience, motivated by dual goals of prevention and early detection of disease (i.e., HIV/HCV). None of the PWID used PrEP and most had never heard of it. When probed about methods for protecting themselves from HIV, most PWID simply stated that they do not share needles, or only did so with trusted romantic partners. SSPs were highlighted as critical facilitators of resilience, serving not just as an available resource but also as motivators for engaging in protective health behaviors. Participants described SSPs as catalysts for using sterile needles, with some attributing their behavior change directly to the availability and accessibility of these programs.

> *"Now that we have [the] needle exchanges here, I definitely use clean needles." 38-year-old man*

Participants described safer sex practices (e.g., avoiding multiple sex partners, using condoms) as a strategy to protect themselves from infection. Regular HIV testing was a less mentioned as a healthy behavioral strategy; participants who reported regular HIV testing noted trying to test every three to six months. Pregnancy, child caregiving responsibilities and personal awareness of a heightened risk for IDU-associated infection were all motivators for regular HIV testing.

Health-promoting cognitive resilience strategies

We identified three types of health-promoting cognitive processes: (a) affirmation of self-worth; (b) rationalization; and (c) reframing anger.

To resist external and internalized stigma, some participants described reaffirming their personal worth after a stigmatizing event. For example, after a physician insisted on dawning four pairs of gloves prior to administering a health exam, one participant reminded herself, "he didn't know me, but I know me, you know." (39-year-old woman). Other methods of affirming self-worth included

not identifying with the substance use disorder, framing the latter as a disease as opposed to a personal attribute, finding solace in religion, and noting that their substance use did not eliminate their positive qualities or goals.

> *"God's the only one that can judge me." 44-year-old man*

Others resisted stigma by rationalizing it as ignorance or an unavoidable part of being PWID.

> *"If someone's judging me for that [substance use disorder] they're not educated on what addiction is" 26-year-old woman*

Anger, while initially an emotional response to stigma and systemic barriers, was reframed by some participants into motivation for constructive action, such as seeking resources, advocating for their health, or reflecting on their rights. This reframing highlights anger as a dynamic component of resilience, enabling participants to channel negative emotions into behaviors that promote agency and self-advocacy. Additionally, anger emerged as a cognitive and emotional response to stigmatizing experiences, particularly in cases of perceived medical maltreatment. Participants described how anger helped them recognize the dehumanizing nature of drug-use stigma and fueled a desire to resist its effects.

> *"So, at the time I felt they didn't care. Then as the time goes by, you know what I'm saying, I get mad. It angers me that, you and I'm saying, how can another human being do that to a human being" 43-year-old man*

Enacting anticipation strategies

Distinctive from the other resilience strategies, anticipation spanned intra- and interpersonal-level resilience and included both health demoting and promoting factors. Anticipation strategies on the individual, intrapersonal-level commonly included activities such as avoiding or delaying healthcare and hiding drug-use at healthcare appointments. Overlapping with maladaptive coping strategies, most participants avoided HIV prevention services [e.g., PrEP] or decided to delay healthcare until their medical condition was life-threatening to avoid the possibility of stigma.

> *"I wouldn't want people around me knowing I was using it [PrEP] because it would make them look at me like I have it [HIV], even though it's a preventative thing." 50-year-old man*
> *"I won't say heterosexuals aren't susceptible to it [HIV], but its [PrEP] more for the gay community… they [friends] would stereotype." 43-year-old man*
> *"I don't go to the hospital unless I'm dying. I don't want to be judged. I don't want to be, you know, made a fool of." 41-year-old woman*

Participants who did seek medical care for drug-use related or other concerns also used various anticipation strategies to minimize the potential for stigmatization from healthcare staff, including avoiding drug-use conversations, using physical methods to hide drug-use (e.g., wearing long sleeves) and avoiding or selectively disclosing information about drug-use.

> *"Before I go in, I clean myself up for a week or so … keep one arm clean of track marks. … I talk to the counselors up here at the clinic with my drug problems, and I talk to a different doctor about my health problems." 30-year-old man*

Participants frequently reported group, interpersonal-level anticipation strategies such as traveling with trusted friends, other PWID, or family. This interpersonal anticipation strategy was used to ensure safety and receipt of quality treatment.

> *"People treat me better when they see my daughter. Yeah, and especially because she's a nurse." 43-year-old woman*

Empowering other PWID

Empowering other PWID emerged as a key interpersonal-level resilience process, characterized by engagement in supportive behaviors. However, many participants perceived this mechanism as unidirectional, noting that while they often provided support, it was rarely reciprocated. Despite this, participants highlighted the personal benefits of helping others, such as increased self-worth and a sense of solidarity.

> *"It makes me feel a little better, you know what I mean? I feel we should help each other out. We're all in the same boat, you know?" 41-year-old woman*

Encouraging preventative actions, particularly promoting HIV testing, was the most reported form of empowerment. Participants who regularly tested for HIV felt comfortable advising others to do the same, recognizing the importance of early detection and treatment.

> *"I tell them, like, it's better safe than sorry. And if they do have it, then early detection is probably going to help them rather than harm them. I would encourage them to do it." 23-year-old woman*

Empowerment also took the form of directly providing resources such as condoms, sterile syringes, Narcan, and education about safe injection practices and the benefits

of HIV testing. Additionally, participants frequently connected others to external resources, including SSPs, drug treatment, and HIV testing services. While discussions about substance use treatment occurred, some participants expressed hesitation, fearing they might seem like "hypocrites" suggesting rehab to other PWID unless the peer was in particularly dire circumstances (e.g., homelessness or repeated overdoses).

PWID also empowered others by offering emotional support with stressful events such as drug-use stigma, relapse, and recovery following overdose. This support often focused on positivity and compassion, described by participants as providing, "a shoulder to cry on" or "an ear."

Seeking social support

Seeking social support from friends, family and other PWID was the least used interpersonal-level strategy. Participants reported seeking social support from (a) systems; (b) friends and peers; (c) family; and (d) current and former romantic partners.

Systems support included supportive interactions with, for example, SSPs substance use treatment centers, and healthcare personnel. Participants' descriptions of SSP support were overwhelmingly positive. SSP staff were described as creating a comfortable, non-judgmental space where PWID could engage in healthy behavioral and risk reduction practices such as disposing of needles safely, obtaining sterile injection equipment, accessing Narcan, or getting referrals to other health or treatment services. A few participants noted receipt of mental health support, which in turn facilitated their management of drug-use stigma. In contrast, only two participants reported positive engagement from healthcare personnel.

Seeking support from family, friends, and peers was described less frequently, as many PWID indicated they did not have close friends and often distrusted their peers. This lack of trust was linked to past experiences of being taken advantage of, with reports of stealing among peers being a common concern.

Although reported uncommonly, peer support was offered from other PWID in the form of sterile syringes or transportation. Receipt of emotional support was discussed, but only following severe traumatic events such as the death of a loved one or being the victim of severe physical violence. Joe, a 38-year-old, male offered the following narrative describing the nature of support exchanged among PWID:

> *"Most [PWID] will tell you that they aren't real social, which is true. But there are times that you do hang out with other people. Mainly it's just a sit-down conversation: 'Hi, how you doing? How's things been?' So just more of an emotional social support." 38-year-old man*

Current and former romantic partners were the most frequently cited social support network. This support primarily revolved around direct provision of resources (e.g., sterile syringes, transport, and Narcan), encouraging preventative actions (e.g., HIV treatment), and emotional support after a stigmatizing event.

Engagement in maladaptive coping processes

Within the resilience framework, maladaptive coping processes reflect the challenges participants face in navigating stigma and highlight missed opportunities for resilience-building. Participants navigating stigma often described using substances and self-isolating, which limited access to social support. Delaying urgent healthcare needs or prematurely leaving treatment were used commonly to avoid the negative experiences associated with healthcare-related stigma. Healthcare was often delayed until symptoms became critical, such as severe pain from dental or skin abscesses or crises like septicemia or chronic liver disease caused by untreated HCV infection. For example, one participant with stage 3 breast cancer described skipping chemotherapy and radiation appointments due to the emotional distress caused by stigma experienced within healthcare settings.

In some instances, participants left healthcare settings against medical advice or performed untrained self-treatment, driven by a fear of judgment. These actions, while harmful to health, reflected efforts to protect their emotional well-being. For instance, one participant recounted how perceived stigma from medical staff led her to attempt a risky medical procedure on herself:

> *"I went to the emergency room, and I'm thinking [that the hospital staff are thinking]: 'This is the third time this [expletive] has come in here and got an abscess there.' So I stole a box of scalpels and I lanced it probably three, four hours after I got home." 24-year-old woman*

Discussion

We explored mechanisms of resilience to intersectional HIV prevention and drug-use stigma among PWID in rural Appalachian Ohio and found that PWID demonstrated resilience across multiple dimensions. Four thematic areas—engaging in healthy behavioral strategies, health-promoting cognitive processes, empowering other PWID, and seeking social support—aligned closely with Harper et al.'s resilience framework. The close alignment with Harper et al.'s framework suggests that, like other

populations with multiple oppressed identities, PWID exhibit resilience processes across individual and interpersonal dimensions [23]. Systems of support, such as SSP, also played a critical role in facilitating these resilience processes by reducing stigma, fostering autonomy, and enabling resource sharing, which are essential for mitigating health disparities among PWID.

The findings highlight opportunities for resilience-based interventions to improve HIV prevention and treatment outcomes among PWID. For example, interventions like peer navigation programs have shown promise in improving engagement with HIV care by leveraging peer networks to build trust and provide tailored support [27, 38, 40]. Similarly, community-based models that integrate harm reduction services with resilience-building components, including mobile health interventions, may be effective in improving HIV prevention by addressing stigma and fostering self-efficacy [24, 52]. Such interventions could be adapted to rural PWID by focusing on empowering peers and encouraging health-promoting behaviors while addressing the unique socio-economic and cultural challenges in Appalachia. To measure the effectiveness of these interventions, developing a reliable scale to assess PWID resilience will be critical for identifying gaps and refining strategies.

Two unique coping strategies—anticipation and maladaptive processes—were identified, each with distinct roles within the resilience framework. Anticipation strategies, spanning both intra- and interpersonal resilience dimensions, reflect proactive efforts by PWID to navigate and mitigate stigma. Examples include self-care behaviors, such as accessing harm reduction services, and recruiting peer support, with peer-based interventions like navigators and harm reduction programs shown to effectively empower individuals to navigate stigma and improve access to care [18, 41]. These strategies align with resilience-building mechanisms by disrupting the pathway from stigma exposure to avoidant behaviors, ultimately promoting well-being and reducing stigma's adverse effects [23]. Strengthening systems of support, such as syringe service programs (SSPs), can mitigate reliance on maladaptive coping and reinforce resilience pathways that improve health outcomes among PWID [4, 48].

In contrast, maladaptive coping strategies, such as avoidance and self-isolation, represent health-demoting behaviors that limit access to resources and undermine resilience. For example, stigma-related healthcare avoidance has been linked to delays in seeking care, leading to worsened health outcomes and increased vulnerability to infectious diseases [19]. These maladaptive processes highlight gaps in systems of support, which are critical for fostering adaptive resilience strategies. Within the resilience framework, these findings underscore the need for interventions that address structural and interpersonal stigma while enhancing supportive environments.

A bi-directional relationship emerged between healthy behavioral strategies and empowering other PWID, highlighting how resilience processes operate synergistically. Within similar study settings, SSPs were particularly valued for their ability to reduce the impact of social stigma by offering anonymous services and treating clients with dignity [26]. Empowering others was a frequently reported resilience strategy, but many participants described this empowerment as unidirectional—offering support to others without receiving it in return. Despite this, these acts of empowerment functioned as dual resilience mechanisms, fostering interpersonal connections while reinforcing participants' sense of purpose and self-efficacy. This dynamic underscores the complexity of resilience, where unreciprocated acts of support can still provide meaningful personal and community benefits.

Social support, however, was the least utilized resilience strategy, with participants as many reporting a lack of close friendships and distrust of peers, often linked to past negative experiences such as being taken advantage of or theft. These align with research showing that stigma undermines trust within social networks, which are vital to health and behavior among PWID [33]. Tailored interventions to strengthen social networks could enhance social support and resilience, ultimately improving health outcomes. Additionally, few participants reported using or being aware of PrEP, which was often perceived as a medication for LGBTQ + individuals, highlighting the need for culturally tailored, stigma-sensitive messaging to promote PrEP among rural PWID [2].

Resilience is a culturally specific mechanism shaped by both individual and structural factors. Our findings should be interpreted within the unique cultural and socio-economic context of rural Appalachian Ohio, which has experienced significant economic downturn, widespread poverty, and disparities in education, employment, and health outcomes [1]. These socio-economic conditions, coupled with the predominantly white demographic of Appalachian communities, heavily influence resilience pathways. Consequently, these findings may not directly translate to PWID in regions with differing cultural, racial, or socio-economic contexts. Future research and interventions should account for these contextual factors when applying resilience mechanisms to other populations or settings.

Our findings suggest that systems of support, such as SSPs, play a critical role in enhancing resilience to intersectional drug-use and HIV prevention stigma by fostering autonomy and enabling peer empowerment. However, recruitment limitations in counties without

SSPs, such as Jackson, Vinton, Meigs, and Pike, may have influenced our findings, as PWID in these areas could have different resilience perspectives than those in regions with SSP access. Additionally, this study did not disentangle the specific effects of internalized, anticipated, and enacted stigma, which could have added nuance to the identified pathways. Future research should address these limitations by expanding recruitment to areas without SSPs and exploring the interplay of different stigma types to ensure a more comprehensive understanding of resilience mechanisms across diverse settings.

In conclusion, PWID in rural Appalachian Ohio demonstrated resilience across six thematic areas, with systems of support, such as SSPs, playing a vital role in fostering autonomy and peer empowerment. A bi-directional relationship between healthy behavioral strategies and empowering others highlights the potential of leveraging resilience processes to reduce stigma and improve engagement with HIV prevention services. Findings suggest that empowering peers and anticipation strategies are key resilience processes, while maladaptive coping and limited bidirectional social support emphasize the need for interventions that build resilience and reduce stigma. Tailored systems of support and culturally appropriate, resilience-focused interventions are essential to fostering adaptive coping and enhancing the uptake of HIV prevention strategies, including PrEP, among rural PWID to reduce the risk of future infectious disease outbreaks.

Abbreviations

HIV	Human immunodeficiency virus
PWID	People who inject drugs
SSPs	Syringe service programs
IDI	In-depth qualitative interview
PrEP	Pre-exposure prophylaxis
HCV	Hepatitis C virus
IDU	Injection drug use

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Availability of data and materials
Data are available upon request.

Declarations

Ethics approval and consent to participate
The study protocol and research tools were approved by the Ohio State University Institutional Review Board.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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