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Development and validation of a novel scale for measuring interpersonal factors underlying injection drug using behaviors among injecting partnerships

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Abstract

Background—People who inject drugs with sexual partners or close friends have high rates of syringe/ancillary equipment sharing and HIV and hepatitis C virus (HCV) infection. Although evidence suggests that interpersonal factors underlie these higher risk profiles, there is no quantitative measure of how interpersonal factors operate within injecting relationships. We aimed to develop and validate a quantitative scale to assess levels of injecting drug-related interpersonal factors associated with risky injecting behaviors within injecting partnerships.

Methods—We conducted qualitative interviews with 45 people who inject drugs (PWID) who reported having injecting partners to inform item development, and tested these items in a quantitative study of 140 PWID from San Francisco, USA, to assess internal reliability (Cronbach's alpha) and validity (convergent, and discriminant validity).

Results—With results from the qualitative interview data, we developed the Interpersonal Dynamics in Injecting Partnerships (IDIP) scale with 54 final items for 5 subscales of injecting-related interpersonal factors. Exploratory factor analysis revealed 5 factors ("trust", "power", "risk perception", "intimacy", and "cooperation") with eigenvalues of 14.322, 6.177, 3.548, 2.463, and 2.138, explaining 57% of the variance, and indicating good internal reliability (alpha: 0.92–0.68). Strong convergent validity was observed in bivariate logistic regression models where higher levels of trust, intimacy, and cooperation within partnerships were positively associated with

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partners sharing needles and injecting equipment, whereas higher levels of power and risk perception were negatively associated with partners sharing needles and injecting equipment.

Conclusions—These findings offer strong evidence that the IDIP scale provides a psychometrically sound measure of injecting drug-related interpersonal dynamics. This measurement tool has the potential to facilitate additional investigations into the individual and collective impact of trust, intimacy, power, cooperation, and risk perception on injection drug using behaviors and engagement in HIV and HCV testing and treatment among PWID in a variety of settings.

Keywords

scale development; injection drug use; injecting partnerships; dyad; HCV

Introduction

People who inject drugs (PWID) in middle- and high-income countries, including the United States remain disproportionately affected by hepatitis C virus (HCV) and HIV infection (Centers for Disease Control and Prevention, 2012; Mathers, et al., 2008). The high prevalence (30–70%) of syringe and ancillary injection equipment (e.g., cookers, cottons, and rinse water) sharing that persists among injecting partners when preparing and injecting drugs helps to explain why HCV incidence remains high (Hagan, et al., 2010; Jordan, et al., 2015; Meghan D. Morris, et al., 2016; Under Review). HCV transmission occurs most often between dyads. Current research indicates that injecting partners in close relationships (e.g., close friends, family members, sexual partners) have substantially greater odds of sharing equipment and elevated rates of both HIV and HCV infection compared to casual or injecting-only partnerships (Hahn, et al., 2002; M. D. Morris, et al., 2014; Shaw, Shah, Jolly, & Wylie, 2007; Sherman & Latkin, 2001; Sherman, Latkin, & Gielen, 2001; Tracy, et al., 2014; Unger, et al., 2006). Given the role close relationships play in mediating individual risk, in order to be successful, risk reduction strategies must address the interpersonal factors of injecting partnerships.

A significant obstacle to understanding the mechanism by which interpersonal factors within injecting partnerships influence injection behaviors is the lack of a psychometrically validated measure of the construct. Qualitative studies have provided excellent insights into the role interpersonal factors play within injecting partnerships. Trust, intimacy, and care and cooperation are continually identified as factors influencing how individuals decide and participate in injecting drugs with others; with recent research expanding beyond sexual-injecting partnerships to acknowledge the relational qualities nonsexual injecting partners also share (Fraser, Rance, & Treloar, 2015; Ho & Maher, 2008; Lazuardi, et al., 2012; M. D. Morris, et al., 2015; Neaigus, et al., 1994; Simmons & Singer, 2006). For example, because Partner1 trusts Partner 2, Partner 1 is more willing to put Partner 2's wellbeing ahead of Partner 1's own, resulting in Partner 1's decision to reuse a previously used needle so Partner 2 could inject with the only new needle. While qualitative data provide important narrative evidence of the multidimensional effect interpersonal factors have on individual risk, these studies are limited in their ability to directly measure specific injection drug-related interpersonal factors driving observed risk behaviors.

While researchers have theorized the importance of intimacy and other interpersonal factors in understanding injecting behaviors within injecting partnerships, few have attempted to measure the relational qualities related to drug use, including injection drug use (Cepeda, et al., 2011; Gyarmathy, Neaigus, Ujhelyi, Szabo, & Racz, 2006; R. A. Johnson, Gerstein, Pach, Cerbone, & Brown, 2002; Latkin, et al., 2011). Previous measures of interpersonal factors have either been single-item measures assessing trust related to disease status disclosure (e.g., If someone you inject with tells you their HIV status, how sure are you of their status?), or focus on items that describe social relations more generally (e.g. getting vs. giving drugs) rather than dyadic relationship qualities. Other studies use proxy measures such as living together or "recent sexual behavior." To our knowledge, only one study measured characteristics of intimacy (defined as closeness), using a multi-item partner-specific measure (R. A. Johnson, et al., 2002). A social network study conducted in Washington D.C. by these authors measured reciprocal assistance as a composite score of both network partners' answer to six items: "When was the last time you gave '*Partner*': (1) drugs, (2) needles, (3) money, (4) food, (5) a place to stay, (6) advice?" and found that higher levels of mutual assistance were associated with high risk injecting behaviors. While these findings deepen the description of one partnership quality (reciprocity) as a mechanism underlying injecting behaviors, they do not measure other interpersonal factors that may be important, such as trust or power.

Our goal was to address these issues by developing a theoretically based and psychometrically validated multi-domain measure of interpersonal dynamics within injection drug using partnerships. The current paper focuses on the development and testing of a measurement scale for injection-related interpersonal factors in the context of injecting partnerships. Two phases are reported here: (1) the development of the interpersonal dynamics in injecting partnerships (IDIP) scale and (2) the validation of the IDIP scale and the evaluation of its psychometric properties.

Phase 1: Item creation and refinement

Methods

Overview—We conducted in-depth interviews with PWID (two samples), literature reviews, and discussions with content experts to inform the development of injection drug-related interpersonal factors. Next, we conducted cognitive interviews to refine and assess item interpretation and to finalize item structure.

Sample and Qualitative Interview Procedure—From January to April 2014, we used purposeful sampling to conduct semi-structured in-depth interviews with members of injecting partnerships to elicit broad information on two questions: "What are the major domains of interpersonal dynamics that influence injecting behavior most?" and "How do these domains differ within different types of injecting relationships?"

First, semi-structured interviews with both members of several injecting partnerships (sample 1: n=18 individuals, 9 partnerships) from the HITS-c Study were conducted (by MM). The HITS-c Study is an epidemiological study of HCV seroconversion and associated risk behaviors among PWID in Sydney, Australia. Methods for the partnership qualitative

interviews have been published elsewhere (M. D. Morris, et al., 2015). Next, in-depth interviews were conducted (by MM and EA) with 27 people (<30 years old) from the UFO study who injected drugs with another person in the past month (sample 2). The UFO study is a community-based prospective study of drug using behaviors associated with the acquisition and transmission of HCV and HIV in San Francisco, USA (Hahn, et al., 2002; Page, et al., 2009). In both samples, participants were selected using purposive sampling techniques from existing cohorts of PWID to estimate HCV incidence and assess exposure behaviors. Purposive sampling allowed for a diverse sample representing both genders and a variety of injecting behaviors. A manuscript detailing substantive findings from sample 2 is in progress. The University of California, San Francisco Human Subjects Research Ethics Committee approved all protocols, and participants were reimbursed $30 USD for their time and participation.

Interview topics—A semi-structured in-depth interview guide was developed to elicit information on specific incidents of "risky behavior." The interview guide focused on the relationship context in which the behavior occurred; participant perspectives on what enabled "safer" injecting when injecting with others; trust and truthfulness within different injecting partnership relationships; willpower and the impact of heroin withdrawal in the context of injecting partnership relationships; relationship dynamics as they develop over the lifespan of an injecting partnership; and unique attributes of sexual injecting partnerships that influence the higher risk injecting behaviors observed in previous studies (De, et al., 2009; Gyarmathy, et al., 2010; Hahn, Evans, Davidson, Lum, & Page, 2010; M. D. Morris, et al., 2014). Interviews focused on eliciting narratives about the most recent high-risk injecting event (i.e. needles/syringes or other injecting equipment, shared or reused) within partnerships. Probes were used to understand how economic, physical environment, policies, social, interpersonal, and individual factors differed in high-risk situations compared to both "average injecting experiences" with that partner as well as to experiences injecting with other partners. Questions were also asked to elicit information on how interpersonal factors varied between different injecting partnerships. All interviews were audio recorded.

Analysis—Following a grounded theory approach (Strauss & Corbin, 1997), were data collection and preliminary data analysis occurred in tandem. After each interview, the researcher (MM or EA) wrote notes to capture key concepts. This process informed the direction of subsequent in-depth interviews and refined the in-depth interview guide to capture new information. Following data collection, interviews were transcribed, checked for accuracy and interviewer consistency, de-identified, and cleaned. Using an established codebook, both MM and EA thematically coded and organized data using a qualitative data software program (Atlas.ti 6.0)(Muhr, 2009). See supplemental table 1 for codebook.

Theoretical perspectives were also used to frame item development—We reviewed social and psychological theories of relationship and interpersonal dynamics including the Social Exchange Theory (Emerson, 1976), Social interdependence theory (Emerson, 1976; D. W. Johnson, 2003), and Theory of Gender and Power (Connell, 1987). Social Exchange Theory posits that behavioral decisions depend on the perceived trade-offs of costs and rewards of the behavior compared to alternatives within the context of social

interactions (Emerson, 1976). Social Interdependence Theory suggests that the way in which peoples' goals are structured determine individual interaction behaviors which then determine the outcomes of the situation (Deutsch, 1962). Since previous evidence shows that female PWID and sexual-injecting dyads are at greater risk of sharing injecting equipment, we consulted the Theory of Gender and Power to better frame the gender-based power imbalances underlying men's disproportionate power in decision making (Connell, 1987). Lastly, we reviewed existing scales, including the seven-item Couples Risk Reduction Communication Skills (Gómez & Marin, 1996), the 31-item Dyadic Adjustment Scale (Spanier & Thompson, 1982), the 23-item Sexual Relationship Power Scale (Pulerwitz, Gortmaker, & DeJong, 2000), and a revised Conflict Tactics Scales (Straus, Hamby, Boney-McCoy, & Sugarman, 1996).

Based on the qualitative analysis, literature review, and content feedback from the field's experts on drafted items, we developed a draft interview with items representing five constructs of injecting-related interpersonal factors (trust, intimacy, cooperation, power, and risk perception). Next, we conducted cognitive interviews to refine the scale items and to ensure scale completeness and comprehensibility by interviewing seven additional individuals to determine how the intended population interpreted and understood the draft items. Each cognitive interview lasted approximately one hour and ended with an open-ended discussion about the acceptability of the overall scale and research direction (figure 1). The majority (five) of cognitive interviews were conducted with participants from phase 1 sample 2, half were male and all reported injecting with another person in the past month.

Phase 1 Results

Sample Characteristics—Sample 1 included 18 interviews of partners from 9 partnerships from an ongoing cohort study in Sydney, Australia (M. D. Morris, et al., 2015). The majority (44%) were male-female partnerships who also identified themselves as intimate sexual partners, one (11%) partnership was male-male and engaged in a casual sexual relationship. Three (34%) partnerships were family members; one was a father-daughter and two were sibling partnerships. Median age was 30 (IQR: 28–35), partners reported knowing each other for a median of 9 years (IQR: 2–12 years), and two-thirds injected together weekly or more often in the past month. Two-thirds (66%) reported exclusively injecting together, four (44%) partnerships reported a recent event where a needle/syringe was shared, and seven (77%) reported a recent event where ancillary equipment had been contaminated or reused.

Sample 2 consisted of 27 individuals recruited from an ongoing cohort study in San Francisco, USA, who identified as female (F; n=13), male (M; n=13 men, and transgender (TG) (n=1). Median age was 25 years (IQR: 23, 27). Just over half (55%) of the participants were in an opposite gender injecting partnership (M-F/F-M); 33% of the partnerships were males injecting with other males and 11% of the partnerships were women injecting with other women and one was a transgender injecting partnership. Partners reported knowing each other for a median of 24 months (IQR: 6, 84 months), the median number of days the partners injected together in the past month was 10 (IQR: 2, 30 days), and 25% reported injecting in their partnerships daily during the last month. Within the past 3 months, about

one third of partnerships shared (distributive or receptive) needles/syringes with each other, 85% reported preparing drugs in the same container before injecting, and 37% reported always using the same container to prepare drugs.

Item-Pool Selection—Sixty-two items were developed based on the in-depth interviews, literature review, and discussions with content experts. Eight items were dropped after cognitive interviewing due to a lack of clarity or importance. Additional modifications to grammar, word choice, or answer options were made based on feedback from cognitive interviews. The final items included aspects of trust, power, risk perception, intimacy, and cooperation pertaining to injecting with another person. Care was taken to include statements reflecting a diverse set of injecting partnership types (e.g., sexual, friend, family-member, newly formed). Statement wording was written for a sixth grade reading level and double negatives were avoided. The complete item pool consisted of 54 items, which were used in Study 2 to create the final scale.

Answer Choice Format—By breaking up scale items into modules, each with a different answer option, we hoped to reduce respondent fatigue and increase the likelihood of obtaining more accurate answers (DeVellis, 2012). During cognitive interviewing, participants noted that the different answer values within the sections helped keep them engaged. Therefore, the choices for the final item pool consisted of four different Likert scale answer options: (1) always, most of the time, about half the time, sometimes, never; (2) extremely, very moderately, slightly, not at all; (3) a great deal, a lot, a moderate amount, a little, nothing/not at all; (4) agree a great deal, agree a lot, agree a moderate amount, agree a little, agree not at all. The last module asked participants to compare themselves to their identified injecting partner on different drug use behaviors (e.g., who cares more about how drugs are prepared?"). Four response options were provided following this example: partner cares more, I care more, we care equally, neither of us care. A sixth answer option (not applicable, don't know, decline) was included in each module.

Phase 2: Scale administration and evaluation

Overview

The second phase was conducted to finalize items for the IDIP scale and to assess its psychometric properties. An exploratory factor analysis was conducted to inform decisions concerning the selection of the most useful items into the scale.

Methods

Sample—A convenience sample of 140 young adults currently injecting drugs and enrolled in the UFO Study was used for the scale development activities between January 2014 and January 2015. Eligibility criteria did not require sharing of injecting equipment. The University of California, San Francisco approved all study protocols and instruments, and participants were provided $10USD for participation in additional IDIP questionnaire, in the addition to their $20USD payment for their study visit.

Data collection—Scale items from the draft IDIP scale were included in a questionnaire administered to current UFO participants reporting having injected in the same physical space with another person in the past month. Interviews included additional questions about individual injecting behaviors, injecting partnerships (number, type, and drug using behaviors), and HCV and HIV knowledge. Participants who reported injecting with another person within the past 30 days were administered the IDIP scale as part of the larger interview survey. Participants were asked to respond to questions about one injecting partner with whom they had injected with in the past month.

Additional measures—As part of the validation process, associations between the IDIP Scale and theoretically relevant variables were tested. Syringe sharing was measured with two dichotomous measures collected: (1) receptive syringe sharing, "Have you ever injected with a needle/syringe that *Partner* had already injected with?" and (2) distributive syringe sharing, "Has *Partner* ever injected with a needle/syringe that you had already used to inject drugs?" We also included a dichotomous measure for sharing containers/cookers for mixing drugs: "Have you and *Partner* ever prepared drugs in the same previously used cooker/ container before injecting drugs?" The following three additional individual-level measures were used to assess discriminant validity: have you ever (1) used someone else's rig after they've used it? (Ever borrowed anyone's used needle/syringe), (2) let someone else use your rig after you used it? (Ever lent your needle/syringe to anyone); and (3) share[d] a cooker or other container for dissolving drugs, or used one that had already been used by someone else? (Ever shared container/cooker when preparing drugs with someone).

Statistical Analysis

<u>a) Assessment of construct validity and reliability:</u> Construct validity of the IDIP scale was assessed via exploratory factor analysis (EFA). During the development of the instrument (phase 1), we hypothesized that the scale would assess injecting-related interpersonal dynamics through five sub-domains: trust, power, intimacy, cooperation, and risk perception. We anticipated that the number of items per domain might vary and that some items could be associated with factors across sub-domains, thus we conducted exploratory factor analysis of the 54 items using robust weighted least-squares estimation suitable for use with ordinal items and geomin rotation of factor loadings in M*plus* 7.4. To assess which items were retained within factors, we relied on the number of eigenvalues greater than 1.00 and scree plots (Ferguson & Cox, 1993). Internal reliability for subscales based on the extracted factors was assessed using Cronbach's coefficient alpha (Cronbach LJ., 1951).

<u>b) Convergent validity assessment:</u> We examined convergent validity by assessing how closely the theoretical associations between scale constructs and select variables matched the observed associations. Each IDIP domain was conceptualized as a latent variable measured by the associated IDIP items. Three binary (y/n) partnership-level measures captured partnership injecting drug use: (1) borrowing *Partner's* used needle/syringe, (2) lending used needle/syringe to *Partner*, and (3) preparing drugs in the same container/cooker as *Partner* before injecting. We hypothesized that higher levels of trust, power, intimacy, and cooperation would be positively associated with borrowing and lending one's needle/syringe

with *Partner*, but a higher level of risk perception would be negatively associated with this action. Similar relationships were presumed between preparing drugs in the same cooker/container with *Partner* and the five latent variables. To test convergent validity, the above three binary outcomes were regressed onto each latent variable structure using logistic regression methods via maximum likelihood estimation to obtain odds ratios (ORs) of the outcomes per unit change in the IDIP latent variable.

c) Convergent and discriminant validity assessment: We assessed convergent and discriminant validity of the IDIP domains by correlating the factors with partnership-level drug use behavior outcomes chosen *a priori*. We then examined discriminant validity, which demonstrates the extent to which items are not associated with variables that they theoretically should not be associated, of the five latent variables by conducting regressions on the five IDIP factors and three injecting network-level risk variables: ever borrowing anyone's needle/syringe, lending anyone's needle/syringe, and mixing up drugs in the same cooker/container as someone else.

Phase 2 Results

The majority of the 140 participants were male (66%), HCV antibody negative (63%), reported injecting with more than one person in the past month (90%), and injecting heroin (60%) most often. The median age was 25 years (IQR: 23,28) and partnerships had injected together a median of 25 days (IQR: 7,30) in the past month. Lifetime receptive and distributive needle/syringe sharing with any partner was 66% and 68%, respectively, with fewer participants reporting receptive (25%) or distributive (30%) needle/syringe sharing in the past three months. The majority (85%) of participants had ever mixed drugs in another person's used container while 64% had ever injected the residue from someone else's cotton or cooker/container. Since beginning to inject with *Partner*, 35% reported injecting with *Partner's* used needle/syringe, 30% reported lending *Partner* their needle/syringe to inject, and 80% prepared drugs with *Partner* in the same container before injecting.

Exploratory factor analysis—Exploratory factor analysis (EFA) of the 54 IDIP items suggested the presence of five common factors with eigenvalues of 14.322, 6.177, 3.548, 2.463, and 2.138 respectively (supplemental figure 1), which accounted for 57% of the shared variance among the 54 items (fit statistics: RMSEA: 0.08 CFI: 0.90; SRMR: 0.05). Prior to running the reliability analyses, 12 items were dropped due to either low response, split loadings, or low factor loading values. Table 1 lists dropped items and final factor loadings. Supplemental figure 1 displays eigenvalues from EFA. We conducted sensitivity analyses associating each dropped item with borrowing *Partner's* needle/syringe or lending their needle/syringe to *Partner* and found significant associations for only two items (love5h and love5f). Higher values on the item, "when using drugs together, how often do you do what [Partner] prefers?" was positively associated with borrowing *Partner's* needle/syringe (OR 1.96, 95% CI: 1.32, 2.93). A higher value on the item, "when you put in more money, who more often prepares the drugs?" was negatively associated with lending their needle/syringe to Partner, indicating that when the participant puts in more money and prepares the drugs they are at reduced odds of lending their needle/syringe to *Partner* (OR: 0.59, 95%CI: 0.36, 0.95).

Internal reliability analyses—Reliability for the five subscales implied by the factor analysis solution was generally high: Factor 1 (alpha: 0.9243), Factor 2 (alpha: 0.7742), Factor 3 (alpha: 0.7207), Factor 4 (alpha: 0.6820), and Factor 5 (alpha 0. 9014) (Table 1).

Convergent and discriminant validity—Level of trust was positively associated with both borrowing *Partner's* used needle/syringe (OR: 2.35, 95% CI: 1.48, 3.72) and ever lending their used needle/syringe to *Partner* (OR: 1.79, 95% CI: 1.11, 2.87) (Table 2a). Participants reporting greater intimacy with their *Partner* were more likely to borrow their *Partner's* used needle/syringe (OR: 2.26, 95% CI: 1.40, 3.64) and mix drugs in the same container as their *Partner* (OR: 2.05, 95% CI: 1.12, 3.74). Participants reporting higher levels of cooperation had greater odds of reporting mixing drugs in the same container as their partner (OR: 1.42, 95% CI: 1.04, 1.94). Conversely, participants reporting higher levels of power and risk perception with their *Partner* were less likely to engage in needle/syringe sharing with their *Partner* (Table 2a). No associations were found between interpersonal domains and the injecting network-level risk measures, when not specific to a partner, indicating good discriminant validity (Table 2b).

Discussion

The main goal of our study was to develop and validate a measurement scale for injection drug related interpersonal factors. We found support for the reliability and validity of the IDIP scale via EFA. Furthermore, participant scores on the five IDIP latent variables were associated with partnership-level sharing behaviors. We found that higher partnership levels of trust, intimacy, and cooperation were positively associated with partners sharing needles/syringes and ancillary injecting equipment, whereas higher levels of power and risk perception were negatively associated with partners sharing needles/syringes and injecting equipment. These results had relatively large associations for a one-point increase in factor score. None of the five domains were significantly associated with injection-related sharing behaviors that were not partner-specific, suggesting strong discriminant validity. As such, there may be a role for the IDIP scale in assessing the impact of the intersection of injecting related interpersonal factors and traditional risk behaviors within drug using dyads.

The IDIP scale was developed to assess interpersonal dynamics in injecting partnerships and showed strong convergent and discriminant validity when applied to partnership-level data. Interpersonal factors are innately dyadic variables. The strong convergent validity suggested by our study's findings encourage expanded application to dyad studies where levels of injection drug-related trust, intimacy, power, risk perception, and cooperation can be measured from both injecting partners. Moreover, the IDIP scale allows the simultaneous study of these injection drug-related interpersonal factors. Future studies applying the IDIP scale to dyad studies where data is collected from both members of an injecting partnerships will provide insight into the extent to which each partner influences the other's actions (Karney, et al., 2010). A dyadic application of the measurement scale will allow researchers to assess at what level and under what circumstances a partner's attributes influence individual behaviors. Doing so may expand analytic and theoretical frameworks to assess the mutual influence of interpersonal dynamics, and shed light on the mechanism underlying injection drug using behaviors across different types of partnerships. There is great need to

assess the interpersonal factors underlying safe injecting practices that also exist within many injecting partnerships (Knight, Purcell, Dawson-Rose, Halkitis, & Gomez, 2005; M. D. Morris, et al., 2015; Simmons & Singer, 2006).

Our research focused on developing a measurement tool to directly measure interpersonal factors in order to better study the mechanism underlying injection drug using behaviors. However, it remains important to recognize the influence of structural factors. Young adults who inject drugs encounter ongoing political, social, economic, and physical challenges altering their access to housing, sterile injecting equipment, health care services, and social support; resulting in differing levels of marginalization (Rhodes, et al., 2003). Individually, such structural factors increase one's risk for syringe and ancillary equipment sharing and subsequently the transmission of HIV and HCV, but there is also an additive effect (Allen, et al., 2012; Artenie, et al., 2015; Craine, et al., 2009; Hahn, Page-Shafer, Ford, Paciorek, & Lum, 2008; Iversen, Wand, Topp, Kaldor, & Maher, 2013; Maher, et al., 2006; Rhodes, et al., 2003). Karney et al. make the point that coordinated behavior between two people is influenced both by the interpersonal factors unique to their connection, but also due to sources proximal (e.g., immediate physical environment) and distal (e.g., policies influencing availability of sterile injecting equipment) to the partnership (Karney, et al., 2010). In order to assess the way individuals "succeed or fail" to engage in safer behaviors, an examination of the interaction through which qualities of each partner, their mutual influence (interpersonal factors), and structural factors must be considered within the same analytic model (Kelley, et al., 1983).

This study has some limitations

First, it should be noted that the IDIP scale is in the initial stage of development. Additional studies are needed to further evaluate its reliability and validity in independent samples. Secondly, the relatively small sample size may have influenced our analysis by biasing the item correlations toward the null. However, all five factors had moderate to high item loadings supporting the appropriateness of our sample size (MacCallum, Widaman, Preacher, & Hong, 2001). On the basis of our results, we assume that the fit indices would perform better as sample size increased. While our sample is composed primarily of young adult white males who primarily inject opioids and may not be generalizable to the broader population of PWID, the characteristics of our sample are comparable to other published studies of young PWID in the U.S. (Amon, et al., 2008; Lankenau, Kecojevic, & Silva, 2015). The higher injecting frequency and expanded social network of stimulant users may contribute to different interpersonal dynamics among injecting partnerships. Future research should explore the way injection drug-related interpersonal factors influence sharing behaviors across partnership type and partnership duration.

The goal of our study was to develop a new measure to aid the direct study of the interpersonal dimension unique to dyad-level outcomes, including needle/syringe and ancillary equipment sharing. Even with increased access to HCV testing, sterile injecting equipment distribution, and health information, syringe/needle and ancillary equipment sharing still occurs within injecting partnerships. Successful prevention of needle/syringe and equipment sharing likely requires combination and multilevel interventions

(Freudenberg, 1990). Findings from future studies applying the IDIP scale can inform how prevention strategies can expand to simultaneously target the interpersonal dimension. We suggest three primary areas in which the IDIP scale may aid the expansion of prevention: (1) Existing structural interventions (such as HCV testing and counseling) could first directly target dyads by encouraging partners to test together. Counseling programs could leverage partnership-level injection drug-related interpersonal factors by including status disclosure sessions that reflect these partnership qualities. Therefore, providing strategies to ameliorate injection drug-related interpersonal dynamics while perceiving the relationship. (2) Existing individual-level interventions, such as programs to increase knowledge of safer injecting practices, could include strategies for individuals to recognize the presence of injection drug-related interpersonal factors across partnerships. PWID often have several injecting partners over the course of their injecting career (Hagan, et al., 2006; Hahn, et al., 2010; Thiede, et al., 2007). Whether injecting within a one-time, short-term, or steady injecting partnership, equipping individuals with strategies to understand interpersonal dynamics can deepen their ability to negotiate safer practices within different partnerships. (3) Partnership-level interventions leveraging interpersonal factors may not be suitable for all types of situations or partnership types. Future studies assessing the value of adapting the IDIP scale to assess the minimum level of injection drug-related interpersonal factors warranting expanded prevention strategies may help policy makers and practitioners tailor both the content of prevention programs, maximize targeted delivery, and identify which groups are suitable for which programs.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Glossary of terms and abbreviations

Construct	Abstractions to conceptualize a latent variable representing a characteristic.
Domain	Broad concept resulting from qualitative data analysis.
Eigenvalue	Represents the variance in the variables that is accounted for by a factor.
Factor	Factors represent the underlying latent dimensions (constructs) that summarize or account for the original set of observed variables.
Factor score	Composite score created for each observation (case) for each factor that uses factor weights in conjunction with the original variable values to calculate each observation's score.
HCV	hepatitis C virus

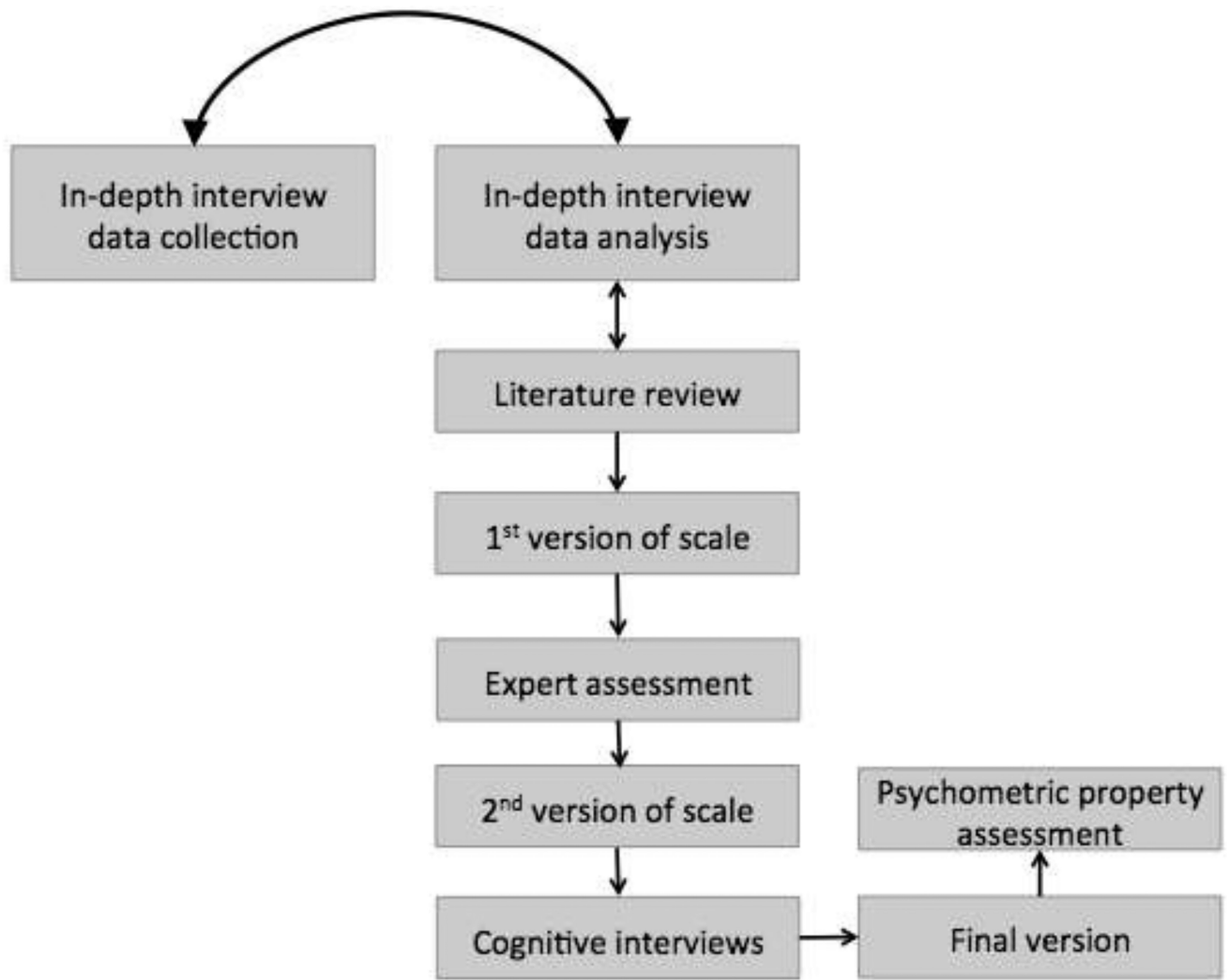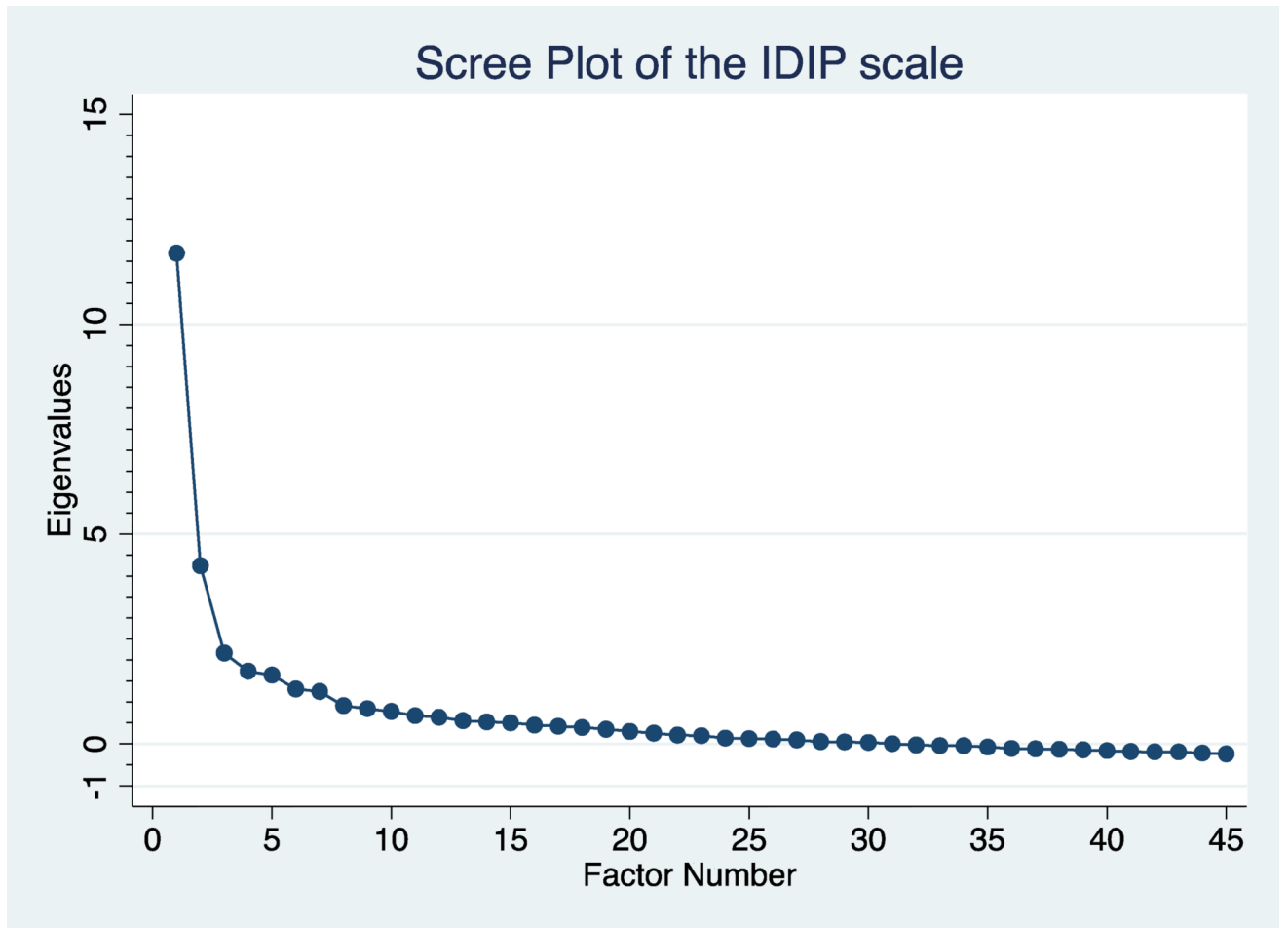| **IDIP scale** | Injecting Dynamics among Injecting Partnerships scale Items: individual quantitative scale questions. |
| **PWID** | person who injects drugs |
| **Scree plot** | A line graph of Eigenvalues that is helpful for determining the number of factors. The Eigenvalues are plotted in descending order. |

Figure 1.
Process to develop the IDIP scale

Figure 2.
Factor Eigenvalues after EFA

Table 1

Loadings by factor (N=140)

Item	Question	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Mean (sd)
Factor 1 loadings: Trust (alpha=0.9243)							
love2c	**How much does [Partner] look out for you?**	**0.881**	0.105	0.304	0.321	0.113	2.2 (1.1)
love2h	**How much do you believe [Partner] loves you?**	**0.875**	0.001	0.321	0.218	0.335	2.4 (1.4)
love4h	**How loyal is [Partner] to you?**	**0.857**	0.145	0.503	0.217	0.082	2.2 (1.2)
love1h	**I tell [Partner] things I don't share with others I inject with.**	**0.836**	-0.099	-0.130	0.345	0.334	2.3 (1.5)
love1m	**I trust [Partner] more than I trust other people I inject with.**	**0.806**	0.227	0.329	0.358	0.256	2.2 (1.4)
love1c	**I believe [Partner] has my back.**	**0.795**	0.345	0.547	0.013	0.056	1.9 (1.2)
love2e	**[Partner] has supported me in the past.**	**0.792**	-0.120	0.092	0.277	0.250	2.4 (1.4)
love4b	**How happy do you feel when you are with [Partner]?**	**0.770**	0.147	0.216	0.491	0.336	2.1 (1.0)
love1k	**It is likely that [Partner] would tell me if she/he had hepatitis C.**	**0.735**	0.336	0.319	0.049	0.141	1.7 (1.1)
love4a	How comfortable do you feel when you inject with [Partner]?	0.724	0.357	0.348	0.383	0.331	1.7 (0.9)
love2a	[Partner] and I have been through (blank) together.	0.722	-0.309	-0.069	0.131	0.055	2.1 (1.1)
love4d	How loyal are you to [Partner]?	0.717	-0.043	0.236	0.267	0.174	1.8 (1.0)
love2i	How much do you look out for [Partner]?	0.685	-0.241	-0.036	0.150	0.176	1.9 (1.0)
love1d	If I was going to share needles/containers, it would only be with [Partner].	0.680	-0.167	0.066	0.411	0.287	3.1 (1.8)
love3i	How often does [Partner] help you get well when you are in withdrawal?	0.680	0.253	0.286	0.047	0.177	2.9 (1.5)
love1f	I believe [Partner] would not fuck me over.	0.679	0.326	0.558	0.179	0.068	2.3 (1.4)
love1g	I believe [Partner] has a responsibility to keep me safe when we inject together.	0.625	0.123	0.157	0.268	0.127	2.5 (1.5)
love1j	It feels like [Partner] is the only person who really cares about me	0.579	-0.237	-0.159	0.564	0.209	3.9 (1.4)
Factor 2 Loadings: Power (alpha=0.7742)							
love3j	**How often does [Partner] get violent with you when you inject together?**	0.068	**0.842**	0.304	-0.339	-0.241	1.2 (0.6)
love3e	**How often does disagreeing with [Partner] create tension between you and [Partner]**	-0.030	**0.820**	0.329	-0.315	-0.135	2.7 (1.5)
love3h	**How often is there tension between you and [Partner] when you inject drugs together?**	0.013	**0.766**	0.302	-0.242	-0.245	1.8 (1.0)
love3m	**How often do you remain silent with [Partner] even though you disagree with him/her?**	-0.006	**0.679**	0.264	-0.365	-0.080	2.3 (1.2)
love1a	**When [Partner] and I inject together the mood is calm.**	0.212	**0.636**	0.185	-0.237	0.040	2.2 (1.1)
love3l	**How often have you and [Partner] argued about who injects first (gets the first hit)?**	-0.207	**0.609**	0.388	-0.152	-0.052	1.5 (1.1)

Item	Question	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Mean (sd)
love3c	How often does [Partner] care more than you do about how drugs are prepared?	0.044	0.413	0.138	−0.306	0.174	2.1 (1.3)
love1b	I believe [Partner] doesn't have hepatitis C.	0.200	−0.392	0.226	0.078	−0.167	2.8 (1.8)
Factor 3 Loadings: Risk Perception (alpha=0.7207)							
love3d	**How often do you think about your risk contracting an infection like hepatitis C**	0.271	0.226	**0.689**	0.040	0.008	2.1 (1.4)
love1i	**I believe [Partner] is a risk taker when he/she injects.**	0.260	0.347	**0.678**	0.037	0.065	2.4 (1.4)
love4g	**How likely do you think it is that you will become infected with hepatitis C or HIV from [Partner]?**	0.162	0.209	**0.655**	−0.201	−0.013	1.7 (1.1)
love1e	**[Partner] hangs out with people I prefer to not associate with.**	0.293	0.376	**0.601**	−0.097	−0.046	2.6 (1.4)
love1f	I believe [Partner] would not fuck me over.	0.679	0.326	0.558	0.179	0.068	2.3 (1.4)
love3b	**How often does [Partner] inject with people you wouldn't inject with?**	0.486	0.202	**0.555**	0.151	0.188	1.9 (1.1)
love2k	How much more than [Partner] do you care about where you inject when you inject together?	0.072	0.239	0.521	−0.163	0.069	2.5 (1.4)
love5c	Who cares more about using clean needles/containers?	0.046	−0.144	−0.502	−0.023	−0.200	2.2 (0.9)
love5d	Who more often makes sacrifices for the other?	−0.207	−0.421	−0.533	0.121	−0.058	2.1 (0.9)
Factor 4 Loadings: Intimacy (alpha=0.6820)							
love2j	**How close would you feel to [Partner] if [Partner] injected you for you?**	0.191	0.087	−0.148	**0.717**	0.250	3.4 (1.6)
love4e	**How close would you feel to [Partner] if you shared needles/containers?**	0.261	−0.137	0.028	**0.652**	0.197	3.9 (1.5)
love1j	**It feels like [Partner] is the only person who really cares about me**	0.579	−0.237	−0.159	**0.564**	0.209	3.9 (1.4)
love4f	**How guilty do you feel when you inject without [Partner]?**	0.372	−0.361	−0.142	**0.562**	0.069	4.3 (1.2)
love5f	**Who would get more angry if questioned by the other about whether a needle/container was clean?**	−0.393	−0.264	−0.241	**0.458**	−0.036	3.2 (1.1)
love4c	**If you share a needle/container with [Partner] how likely are you to share again?**	0.26	−0.012	−0.120	**0.407**	0.354	3.5 (1.5)
love2g	**How upset would [Partner] become if you questioned [Partner] about whether the needle/container was clean?**	0.331	0.362	0.127	**−0.496**	0.186	2.0 (1.3)
Factor 5 Loadings: Cooperation/Vulnerability (alpha 0.9014)							
love3f	**How often do you let your guard down when injecting with [Partner]?**	0.436	0.075	0.018	0.219	**0.977**	2.9 (1.6)
love3k	**I [blank] let my guard down when I am with [Partner].**	0.524	0.094	0.105	0.203	**0.852**	2.9 (1.5)
love3g	How often does [Partner] care more than you do about how injection equipment is obtained?	−0.020	0.279	0.130	−0.174	0.230	1.7 (1.0)
love3a	When using drugs together, how often do you do what [Partner] prefers?	−0.384	0.179	0.105	−0.355	−0.386	3.1 (1.1)
Items not assigned to a Factor due to split or low loadings							
love1l	[Partner] is safer than I am when it comes to injecting.	−0.154	−0.015	−0.099	−0.314	−0.088	2.1 (1.3)
love2b	If you asked if the needle/container was clean, to what extent would [Partner] think you didn't trust him/her?	0.389	0.378	0.194	−0.345	0.154	1.9 (1.3)
love2d	How much closer to [Partner] would you feel if you had sex with him/her?	0.365	−0.254	−0.130	0.430	0.401	3.3 (1.6)

Item	Question	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Mean (sd)
love2f	How different are [Partner]'s injection practices from yours?	0.262	0.215	0.380	-0.034	0.196	2.5 (1.3)
love3a	When using drugs together, how often do you do what [Partner] prefers?	-0.384	0.179	0.105	-0.355	-0.386	3.1 (1.1)
love3g	How often does [Partner] care more than you do about how injection equipment is obtained?	-0.020	0.279	0.130	-0.174	0.230	1.7 (1.0)
love4i	How angry would you be if you got HIV or Hepatitis C from [Partner]?	0.269	0.038	0.034	-0.006	0.085	3.8 (1.6)
love5a	Who cares more about how drugs are prepared?	0.036	-0.163	-0.299	0.058	-0.115	2.3 (0.9)
love5b	Who relies more on the other to get drugs?	0.180	-0.098	-0.213	0.051	0.085	2.5 (1.0)
love5e	Who depends more on the other for survival?	0.280	-0.336	-0.330	0.177	0.063	2.7 (1.1)
love5g	Who helps out who more often?	-0.201	-0.112	-0.327	0.123	0.050	2.3 (0.9)
love5h	When you put in more money, who more often prepares the shots?	0.088	-0.186	-0.235	0.203	0.150	2.0 (0.8)

Bold text indicates items retained in latent factor.

Note: Factor label names reflect the larger domain identified during qualitative analysis. In certain cases, such as the "power" factor, the retained items more closely reflect "dominance/control" or "physical violence", characteristics of the larger domain. See supplemental figure X, for the full codebook with sub-domain descriptions.

Table 2

a: Association between IDIP scale domains and partnership-level injection risk behaviors

	Ever borrowed Partner's used needle (n=125)		Ever lent your used needle to Partner (n=104)		Ever shared container/cooker when preparing drugs with Partner (n=137)	
	Odds Ratio (95%CI)	p-value	Odds Ratio (95%CI)	p-value	Odds Ratio (95%CI)	p-value
Trust	**2.35 (1.48, 3.72)**	<0.001	**1.79 (1.11, 2.87)**	0.017	**1.66 (1.10, 2.54)**	0.02
Power	**0.39 (0.23, 0.67)**	0.001	**0.36 (0.19, 0.69)**	0.002	0.55 (0.27, 1.08)	0.084
Risk Perception	0.91 (0.61, 1.37)	0.66	**0.46 (0.28, 0.76)**	0.002	0.83 (0.50, 1.40)	0.487
Intimacy	**2.26 (1.40, 3.64)**	0.001	1.36 (0.85, 2.20)	0.2	**2.05 (1.12, 3.74)**	0.02
Cooperation	1.28 (0.99, 1.65)	0.05	1.24 (0.94, 1.64)	0.122	**1.42 (1.04, 1.94)**	0.027

b: Associations between IDIP scale domains and individual-level injection risk behaviors

	Ever borrowed anyone's used needle/syringe (n=140)		Ever lent your needle/syringe to anyone (n=139)		Ever shared container/cooker when preparing drugs with someone (n=139)	
	Odds Ratio (95%CI)	p-value	Odds Ratio (95%CI)	p-value	Odds Ratio (95%CI)	p-value
Trust	0.77 (0.54, 1.10)	0.15	0.77 (0.54, 1.10)	0.15	1.06 (0.65, 1.71)	0.82
Power	1.58 (0.94, 2.64)	0.08	1.62 (0.96, 2.77)	0.07	1.50 (0.73, 3.06)	0.27
Risk Perception	1.26 (0.83, 1.90)	0.28	1.04 (0.70, 1.56)	0.85	0.88 (0.52, 1.50)	0.63
Intimacy	0.74 (0.48, 1.15)	0.18	0.83 (0.54, 1.28)	0.4	0.90 (0.51, 1.59)	0.71
Cooperation	0.89 (0.70, 1.14)	0.36	0.91 (0.71, 1.16)	0.44	0.80 (0.58, 1.10)	0.17