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Syringe sharing among people who inject drugs in Tijuana: before and after the Global Fund

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ABSTRACT

Introduction. Needle and syringe programs (NSP) reduce syringe sharing and HIV transmission among people who inject drugs (PWID). However, their effectiveness relies on sufficient individual and population level coverage. In Tijuana, Mexico, the Global Fund (GF) supported NSP during 10/2011-12/2013, but withdrew funds at the end of 2013 following Mexico's re-classification as an upper-middle income country. **Objective.** We tested the hypothesis of higher NSP access and lower receptive syringe sharing among PWID in Tijuana during the GF support period compared to pre-GF initiation and post-GF withdrawal. **Method.** We used data from an ongoing cohort study of PWID in Tijuana (03/2011-10/2015) to implement a segmented regression analysis investigating changes in the self-reported probability of NSP access, reported difficulty in finding sterile syringes and receptive syringe sharing before GF initiation and after GF discontinuation. **Results.** We found a large significant increase in the probability of NSP access (+.07) and decrease in receptive syringe sharing (-.23) right after GF initiation, which continued over the GF period. Subsequently, we found a significant decline in NSP access (-.05) and an increase in receptive syringe sharing (+.02) right after post-GF withdrawal, which continued thereafter. **Discussion and conclusion.** We demonstrated significant temporal changes in NSP access and receptive syringe sharing among PWID in Tijuana after GF initiation and withdrawal consistent with our hypothesis. Coordinated efforts with local authorities are needed to sustain major coverage NSP in settings receiving GF or external aid to guarantee continuity of harm reduction services and prevent relapse in risk behaviors associated with HIV transmission.

Keywords: Harm reduction, Global Fund, syringe.

RESUMEN

Antecedentes. Los programas de intercambio de jeringas (PIJ) reducen la transmisión del VIH entre las personas que se inyectan drogas (PID). Sin embargo, su efectividad depende de una cobertura suficiente a nivel individual y poblacional. En Tijuana, México, el Fondo Mundial (FM) apoyó los PIJ durante 10/2011-12/2013, pero retiró los fondos a fines de 2013. **Objetivo.** Probamos la hipótesis de un mayor acceso a los PIJ y un menor uso receptivo de jeringas compartidas entre las PID en Tijuana durante el período de financiamiento del FM en comparación con el periodo anterior y posterior al FM. **Método.** Usando datos de un estudio de cohorte de PID en Tijuana (03/2011-10/2015), implementamos un análisis de regresión segmentado para investigar cambios en la probabilidad de acceso a las PIJ, la dificultad para encontrar jeringas estériles y el uso receptivo de jeringas compartidas sobre los periodos pre-, durante y post-FM. **Resultados.** Identificamos un aumento en la probabilidad de acceso a PIJ (+.07) y una disminución en el uso de jeringas compartidas (-.23) justo después del inicio del FM, ambos significativos, que se sostuvieron durante el período del FM. Después del retiro del FM, identificamos una disminución en el acceso a PIJ (-.05) y un aumento en el uso de jeringas compartidas (+.02), ambos también significativos. **Discusión y conclusión.** Esfuerzos coordinados con las autoridades locales son necesarios para garantizar una mayor cobertura de los programas de reducción del daño, independientemente de financiamientos externos, para prevenir reincidir en las conductas de riesgo para el VIH en PID.

Palabras clave: Reducción del daño, Fondo Mundial, jeringas.

INTRODUCTION

Needle and syringe programs (NSP) have been shown to effectively reduce syringe sharing among people who inject drugs (PWID) in a range of settings (Fernandes et al., 2017; Sawangjit, Khan, & Chaiyakunapruk, 2017). Access to these programs has been consistently associated with significant reductions in HIV incidence among PWID. Regarding this, a recent meta-analysis (Aspinall et al., 2014) estimated the relative risk of HIV infection among those accessing NSP at .66, 95% CI [.43, 1.01] across all studies and at .42, 95% CI [.22, .81] across six higher quality studies. A recent Cochrane meta-analysis found weaker evidence for effectiveness of NSP on hepatitis C (HCV) transmission (RR .79, 95% CI [.39, 1.61]), with high heterogeneity (Platt et al., 2017). After stratification by region, high NSP coverage in Europe was associated with a 76% reduction in HCV acquisition risk (RR .24, 95% CI [.09, .62]).

Effectiveness of NSP varies between settings, partly as a result of heterogeneity in coverage. The WHO, UNODC, and UNAIDS define “high coverage” as > 60% of PWID contacting NSP services at least monthly in the past year as an indicative target (WHO, UNODC, & UNAIDS, 2013). In addition, the number of syringes received by PWID should be sufficient to cover at least each one of their daily injections to reduce the risk of syringe sharing. A coverage of 200 syringes/PWID/year is given as a target indicator in the context of HIV prevention, but this is higher for HCV prevention and should be based on local injecting practices (WHO et al., 2013).

Tijuana is a border city in Baja California, Mexico, situated on a major illicit drug trafficking route towards the United States. As a result, it has a high prevalence of illicit drug use. An estimated 8,000 to 10,000 PWID live in Tijuana, among whom HIV prevalence is 3.5% (PI: Steffanie Strathdee, 2010-2020) (and higher among female sex workers at 6.7%). HCV prevalence is much higher between 70-90% (Robertson et al., 2014; White et al., 2007), indicating high rates of syringe and injecting paraphernalia sharing. NSP were introduced in Tijuana in 2004, but have operated sporadically through different non-governmental organizations with support from the federal HIV/AIDS prevention agency in Mexico (CENSIDA) and from other agencies and foundations.

From 2011 to 2013, the Global Fund (GF) expanded NSP provision in Mexico translating to high coverage of NSP in Tijuana. However, due to the launch of a new GF funding model in 2013, based on calculations of country income and national disease burden (Bridge et al., 2016) and to Mexico being classified as an upper-middle income country, the GF abruptly withdrew support by December 2013. Before GF investment started in 2011, we began enrolling PWID to participate in an observational cohort study in Tijuana. As the cohort is ongoing, we have monitored

temporal trends biannually before, during, and after the GF funding period, thereby providing an opportunity to investigate the impact of GF investment and withdrawal on NSP access on receptive syringe sharing.

Using data from this cohort, Cepeda et al., members of our team, examined changes in access to NSP among PWID and found self-reported access had significantly declined post GF (Cepeda et al., 2019). We also investigated changes in the number and cost of syringes distributed by one of the main NSPs in Tijuana before and after GF withdrawal. We found that during the GF support period (2012), the NSP distributed 55,920 syringes per month compared to 10,700 syringes per month after its withdrawal (2015/2016), with no changes in the cost per syringe distributed (Cepeda et al., 2019).

In this study we aimed to build on these findings to investigate whether changes in NSP access among PWID were accompanied by parallel changes in receptive syringe sharing among PWID in Tijuana. We expanded the study period to include the pre-GF period to characterize the impact of GF initiation on these outcomes. We hypothesised that 1. GF support initiation resulted in significant increases in NSP access and in significant reductions in receptive syringe sharing, which were sustained over the funding period and that 2. GF withdrawal resulted in significant reductions in NSP access and significant increases in receptive syringe sharing among PWID in Tijuana.

METHOD

Participants

We analyzed data from a cohort study of 734 PWID living in Tijuana, described elsewhere (Robertson et al., 2014). Eligibility criteria included injecting drugs within the past month, being at least 18 years old, being able to speak Spanish or English, and currently living in Tijuana with no plans to move away in the following two years.

Data Collection

Participants were recruited in 2011-2012 using convenience sampling through street-based outreach in ten distinct “colonias” (neighborhoods) of Tijuana where PWID were known to spend time. Participants completed a baseline survey and bi-annual follow up surveys in Spanish or English administered by trained interviewers using computer assisted personal interviewing technology in a private setting. Participants received the equivalent of \$20 USD for each completed survey. Written informed consent was obtained prior to completing any study procedures. The University of California San Diego Human Research Protection Program and the Institutional Review Board for Xochicalco University approved the study protocol.

Measures

Study interviews captured information on drug use, including information on harm reduction service utilization and syringe sharing. We investigated two self-reported main outcomes: “obtaining clean syringes from a NSP within the past six months” and “receptive syringe sharing in the past six months”. We also judged it important to include a variable that could establish the logical link between accessing NSP and reducing receptive syringe sharing and we therefore included “ease in accessing unused syringes in the past six months” as a secondary outcome. Specifically, the variables describing these three outcomes were based on the participants’ responses to the following questions: “In the last six months, from where did you get the syringes you used to inject drugs?”, with the response “Syringe exchange program (you exchanged it yourself)” being categorized as “Yes”; “Of the times you injected in the last six months, how often did you use a syringe that you knew or suspected that it had been used before by someone else?”, with “never” classified as “No”; and “In the last six months, how easy or hard was it for you to get new, unused syringes when you injected drugs?”, with “hard” and “very hard” classified as “difficult to obtain syringes.”

Statistical analyses

We carried out descriptive analyses of the baseline data to characterize PWID participating in the cohort in terms of socio-demographics, injecting behaviors, and access to harm reduction. The sample was disaggregated by gender as it has been shown to be an important determinant of HIV risk among PWID in Tijuana (Strathdee et al., 2011; Strathdee, Lozada, Ojeda et al., 2008; Strathdee, Lozada, Pollini et al., 2008). Chi-square tests and Wilcoxon rank sum tests were conducted to assess differences between men and women for binary and continuous variables, respectively. In particular, we were interested in assessing differences by gender in our three variables of interest to determine whether we needed to control for gender in our primary analysis.

To assess how GF support (which officially started October 15, 2011) and GF withdrawal (which officially started December 31, 2013) may have impacted NSP clean syringe provision and syringe sharing among PWID, we analysed data collected between March 2012 and September 2015. Following Cepeda et al. 2019, we applied methods from interrupted time series analysis (Lopez Bernal, Cummins, & Gasparrini, 2017) and conducted segmented regression (Lopez Bernal et al., 2017; Wagner, Soumerai, Zhang, & Ross-Degnan, 2002) to estimate significant temporal changes in the probability of NSP utilization, difficulty in finding sterile syringes, and receptive syringe sharing within, as well as between, pre-GF funding, during-GF funding, and post-GF funding. For analytical purposes, the calendar time, starting

with the beginning of the study (03/29/2011), was divided into 18 three-month consecutive calendar time periods, with the first three corresponding to pre-GF (Mar 29, 2011 to Jan 13, 2012), the next nine during GF (Jan 14, 2012 to Mar 28, 2014), and the last six post-GF (Mar 29, 2014 to Sep 28, 2015). Although officially the GF support started and ended on the dates mentioned above, we assumed that the GF implementation and its winding down, respectively, took about three months, and as a result, we adjusted the starting dates for the during GF and post-GF periods accordingly. Furthermore, since the surveys assessed the outcome for the previous six-months, responses from surveys that took place three months or less into one of the global funding periods were classified as part of the previous period (e.g., if a survey was less than three months into the post-global funding period, the outcome was assumed to have referred to the during-global funding period).

Mixed effects logistic regression models with random intercepts and an unstructured covariance matrix (to control for within subject correlations) and period as a fixed effect, was used to estimate the probability of each outcome at each of the 18 three-month time periods. Gender was used as a covariate in models in which the outcome was found to significantly differ by gender. Then, the probabilities for each period estimated by the mixed effects logistic regression models were used as the outcome variable in a segmented regression analysis (Lopez Bernal et al., 2017; Wagner et al., 2002) to identify changes from one GF period to the next and to determine whether these changes were sustained within the corresponding GF periods. The segmented regression models were tested for autocorrelation by using the Durbin-Watson test, and auto-regressive terms were added to the models to adjust for auto-correlation. The auto-regressive error models were estimated using the maximum likelihood (ML) method with the Yule-Walker estimates being used as starting values for the iterative computation of the ML estimates. The total R-squared statistics were used to assess the models’ goodness of fit. All analyses were conducted in SAS v9.4.

RESULTS

Baseline descriptive statistics for the 734 PWID included in our analysis are presented in Table 1. Mean age was 37.4 years (range: 18-63), most had completed primary school (61.4%), just over a quarter reported an average monthly income of 3,500 pesos or more, although this was higher among women compared to men (32.5% vs. 24.5%; $p = .02$). Also over a quarter reported experiencing homelessness in the past six months, with this being higher among women compared to men (33.1% vs. 23.5%, $p = .005$). The average duration of injection was 16.2 years, but was significantly higher in men compared to women (18.1 vs. 13.1 years; $p < .001$). The vast majority (94.9%) reported inject-

Table 1

Baseline descriptive statistics of PWID participating in the Tijuana cohort study

Variable	Males	Females	Total	p
Socio-demographics				
Age ^Y	38.8 (8.7)	35.1 (8.9)	37.4 (8.9)	< .001
Education level completed: > primary school	271 (59.4%)	180 (64.7%)	451 (61.4%)	.15
Average monthly income of ≥ 3500 pesos	111 (24.5%)	90 (32.5%)	201 (27.5%)	.02
Experienced homelessness*	107 (23.5%)	92 (33.1%)	199 (27.1%)	.005
Tested positive for HIV (at baseline)	16 (3.5%)	10 (3.6%)	26 (3.5%)	1.0
Injecting behaviors				
Age when first injected* ^Y	20.8 (6.5)	21.9 (7.2)	21.2 (6.8)	.05
Duration (years) of injection ^Y	18.1 (9.4)	13.1 (9.1)	16.2 (9.6)	< .001
Injected ≥ once per day*	440 (96.9%)	255 (91.7%)	695 (94.9%)	.002
Injected heroin*	439 (96.3%)	258 (92.8%)	697 (95.0%)	.05
Injected cocaine*	36 (7.9%)	19 (6.8%)	55 (7.5%)	.59
Injected meth*	122 (26.8%)	84 (30.2%)	206 (28.1%)	.32
Any distributive needle sharing*	333 (73.0%)	197 (70.9%)	530 (72.2%)	.53
Any receptive needle sharing*	325 (71.3%)	199 (71.6%)	524 (71.4%)	.93
Divided drugs with someone else by using a syringe (back loading)*	290 (63.7%)	154 (55.6%)	444 (60.7%)	.03
Used a cooker/cotton/water with someone or after someone else*	302 (66.4%)	187 (67.5%)	489 (66.8%)	.75
Access to harm reduction services				
Found it hard was to get new, unused syringes for injecting drugs*	87 (19.1%)	49 (17.6%)	136 (18.6%)	.61
Got syringes from NSP*	28 (6.1%)	31 (11.2%)	59 (8.0%)	.02
Overdosed*	36 (7.9%)	38 (13.7%)	74 (10.1%)	.02
Number of times overdosed ever ^Y	1.7 (2.4)	1.7 (2.8)	1.7 (2.6)	.15
Ever received professional help for drug or alcohol use	264 (57.9%)	153 (55.0%)	417 (56.8%)	.45

Notes. *Past 6 months; ^YValues represent mean (Standard Deviation).

ing at least once per day, with most injecting heroin (95.0%) as well as methamphetamines (28.1%) and cocaine (7.5%). Approximately 10% had experienced an overdose in the past six months, with this being higher among women compared to men (13.7% vs. 7.9%, $p = .02$), but with no difference in the mean lifetime number of overdoses by gender. Over half (56.8%) reported receiving professional help at least once for drug or alcohol use. In terms of our main outcomes of interest, at baseline, 8% reported obtaining syringes from NSP, 19% reported finding it hard to find clean syringes, and 71% reported receptive syringe sharing in the past six months. A significantly higher proportion of women reported getting syringes from NSP, and therefore we controlled for gender in the mixed effect model that was used to estimate the probability of “getting syringes from NSP” for each of the 18 time periods. However, no significant differences by gender were found in terms of their reported difficulty in finding sterile syringes and in receptive syringe sharing.

For our analysis, the follow-up rate was 91% (i.e., 669/734 participants completed at least one follow-up visit) and while 65 participants did not have a follow-up visit, they were still included in the analysis, with 39 contributing to the pre-GF period and 26 to the during-GF period. A comparison of the participants lost to follow-up with those who completed the follow-up showed that there were no

significant differences between the two with respect to socio-demographic characteristics (data not shown). Figure 1 shows the mean predicted probability of reporting obtaining syringes from NSP (Panel A), finding it hard to get sterile syringes (Panel B) and receptive syringe sharing (Panel C) at each of the 18 time periods spanning the pre-, during- and post-GF periods. Level changes immediately after the GF started and immediately after it ended (i.e., comparing the last estimate of a GF period to the first estimate of the next GF period) are presented in Table 2, together with trend estimates for each pre-, during- and post-GF periods.

Prevalence estimates obtained from the segmented regression model indicated that immediately before the GF support period, less than 10% of PWID reported getting syringes from NSP in the past six months and over 80% reported receptive syringe sharing. During the GF support period, NSP access peaked at 36%, and receptive syringe sharing dropped to 40%. Post-GF withdrawal, NSP access declined to < 20% and syringe sharing increased to 50%. As seen in Figure 1 and Table 2, the predicted probability of obtaining syringes from NSP started increasing significantly in the pre-GF period (+1 percentage points, $p = .002$). However, the increase immediately after the GF support began was much larger and significant (+7 percentage points, $p = .001$) and continued during the GF period (+1 percent-

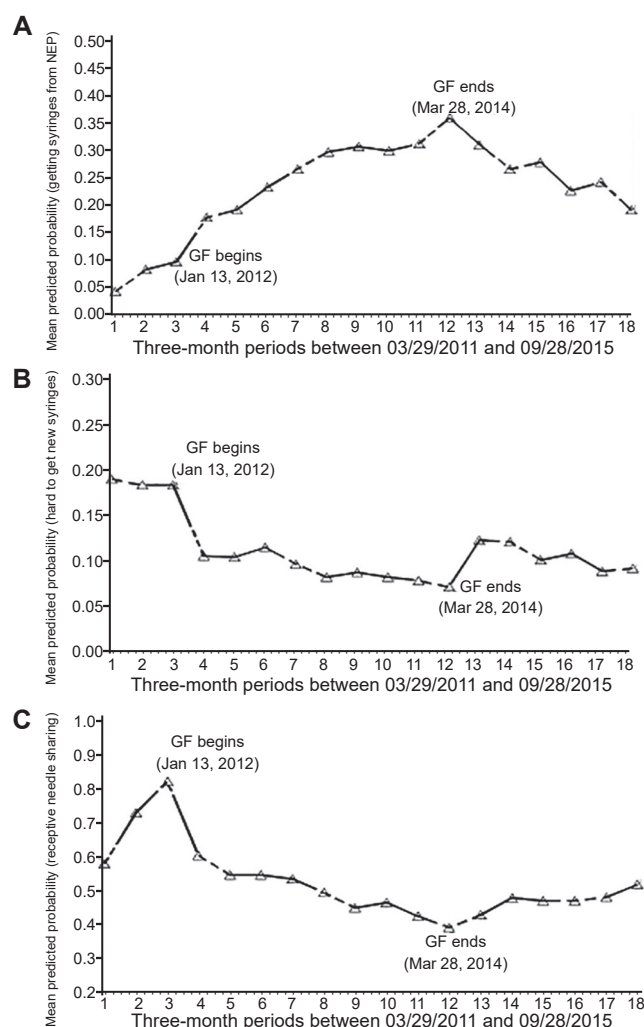


Figure 1. Probability of (A) receipt of syringes from NSP in the past 6 months, (B) finding it hard to get new syringes in the past 6 months and (C) receptive syringe sharing in the past 6 months based on self-reports pre, during and post Global Fund support among PWID in Tijuana.

Note. NSP: needle and syringe programs; PWID: people who inject drugs; GF: Global Fund. For the three estimates within the pre-GF period, the number of observations range was 195-262 observations; for the nine estimates during the GF period there were 194-364 observations; and for the six estimates within the post-GF period, there were 224-263.

age points, $p = .022$). It decreased significantly immediately post-GF withdrawal (-5 percentage points, $p < .001$) and continued to decrease during this period (-4 percentage points, $p < .001$, Table 2).

The probability of reporting difficulty in obtaining sterile syringes was highest during the pre-GF period and this trend was maintained over the entire period. A significant decrease in this outcome (-9 percentage points, $p < .001$) was observed immediately after the GF support began (Table 2) and maintained over the GF support period (i.e., no significant changes). The probability of finding it difficult to obtain sterile syringes increased sharply right after the GF withdrawal (+4

percentage points, $p < .001$) and decreased slightly over the post-GF period (-1 percentage points, $p < .001$).

There was a significant increase in the probability of reporting receptive needle sharing (+12 percentage points, $p < .001$) during the pre-GF period (Figure 1C, Table 2). This decreased sharply immediately after the GF started (-23 percentage points, $p < .001$) and continued to decrease during the GF period (-14 percentage points, $p < .01$). A significant increase in receptive syringe sharing was observed immediately post-GF withdrawal (+2 percentage points, $p = .01$) and over the post-GF withdrawal period (+3 percentage points, $p < .001$).

DISCUSSION AND CONCLUSION

We used data from a cohort of PWID in Tijuana, Mexico, to examine changes in NSP access and in receptive syringe before, during, and after GF support. We found significant changes in the trends of receptive syringe sharing in each of these three periods consistent with our hypothesis of lower probability of syringe sharing during GF support as a result of higher NSP coverage and increased syringe sharing following GF withdrawal. These findings have important public health implications as they provide evidence on both the success of GF funded high coverage NSP in reducing HIV risk among PWID in Tijuana and the negative impact of GF funding withdrawal on these achievements.

We also investigated whether changes in syringe sharing were consistent with trends in the probability of obtaining syringes from NSP and of reported difficulty in finding sterile syringes. During the pre-GF period, the frequency of receptive syringe sharing increased and so did NSP access. While this result is counterintuitive, the effect size for receptive syringe sharing (12 percentage points) was much larger than the effect size for access to NSP (1 percentage point). In turn, we found a much larger and significant increase in NSP access immediately following initiation of GF support, which was consistent with a very large decrease in receptive syringe sharing. This finding is supported by significant declines in reported difficulty in finding sterile syringes. The significant decrease in NSP access immediately post-GF withdrawal and thereafter was also consistent with observed increases in syringe sharing and in reported difficulty in finding sterile syringes, suggesting a strong relationship between GF support and NSP access.

The magnitude of the decrease in syringe sharing during the GF support appears large compared to that of the increase in NSP access. A number of factors might explain this finding: it is possible that during the GF period, only some PWID accessed NSP but gave some of their syringes to other PWID (i.e., secondary syringe exchange) (Snead et al., 2003). Indeed, the kits distributed over this period by at least one of the NSP in Tijuana contained 60 syringes

Table 2

Estimates of level of change comparing the pre-, during, and post-Global Fund support periods and trend change in pre-, during, and post-Global Fund support periods for the probability of getting syringes from NSP, finding it hard to get sterile syringes and receptive syringe sharing in the past 6 months

Variable	Getting syringes from NSP			Found it hard to get new/clean syringes			Receptive needle sharing		
	E	95% CI	p	E	95% CI	p	E	95% CI	p
Pre-global funding trend	.01	.01-.02	.002	-.00	-.01-.00	.563	.12	.11-.13	< .001
Level change after global funding begins (change between pre-global and during-global funding periods)	.07	.05-.08	< .001	-.09	-.09-.08	< .001	-.23	-.24-.22	< .001
Trend during global funding	.01	.00-.02	.022	.00	-.00-.01	.929	-.14	-.15-.13	< .001
Level change after global funding ends (change between during-global and post-global funding)	-.05	-.06-.04	< .001	.04	.03-.04	< .001	.02	.00-.03	.012
Trend change after global funding	-.04	-.05-.04	< .001	-.01	-.01-.01	< .001	.03	.03-.03	< .001

Notes: E = Percentage point change in the outcome probability; CI = confidence interval; p = p-value.

each (Cepeda et al., 2019) and could have been used among several PWID. While one of the responses to the multiple option question used to determine where PWID obtained their syringes included “got syringes from someone who accessed the NSP”, we chose to restrict our definition of NSP access to those who had directly obtained syringes from the NSP, as PWID might not have known from where other PWID obtained their syringes. In addition, other response options included “Spouse, family member, or sex partner”, “Friend”, “Drug dealer”, “Hit doctor”, “Shooting gallery”, and “Bought on the street”, and participants might have favored these options as they provided a better, more evocative, description of who this person was. It is also likely that the increase in NSP access translated into greater reductions in syringe sharing by reducing overall opportunities for sharing (i.e., akin to the herd effect). Interestingly, the changes in NSP access and syringe sharing post-GF support were of much closer magnitude, suggesting that PWID might have found alternative ways of obtaining sterile syringes following reductions in NSP coverage. Also, it is possible that higher syringe availability and higher exposure to safe injecting messages over the GF period contributed to the development of a culture of harm reduction among PWID (Kelley, Murphy, & Lune, 2001).

Our study suggests that while the GF support likely translated into higher NSP access and drastic reductions in syringe sharing, its abrupt withdrawal appears to have had immediate and long-lasting repercussions on both outcomes. Importantly, sudden large-scale increases in syringe sharing at the population level can drive outbreaks of HIV and other bloodborne infections. For example, increases in HIV incidence among PWID were observed after GF withdrawal in Romania (Cséte et al., 2016). The GF has been the global leading donor for harm reduction services for over

a decade making huge contributions towards the scale up of NSP and opioid substitution therapy (OST) (Bridge et al., 2016). However, the proportion of GF resources allocated to harm reduction services hugely decreased following their transitional funding mechanism in 2011 (from USD-135 million in 2010 to USD-13 million in 2011) and it is unclear how the new 2013 funding model has impacted this distribution (Bridge et al., 2016). Restricting funding based on income status ignores the profound health inequalities pervasive in many middle- and high-income countries, which predispose vulnerable communities such as PWID to increased hardship (Bridge et al., 2016). Under the current funding situation, local governments must make additional financial commitments to cover harm reduction needs to prevent the progress achieved so far from being eroded.

In addition to investigating the impact of changes in GF support on NSP access and syringe sharing, our study contributes additional evidence on the association between NSP coverage and syringe sharing available from numerous settings. A consensus study (Wiessing et al., 2017) was recently carried out to develop a framework of indicators for the monitoring and evaluation of harm reduction services. The priority indicators for NSP included “coverage,” “number of needles/syringes distributed/collected,” “provision of other drug use paraphernalia,” and “availability in prisons.”

Limitations

We investigated changes in trends of NSP access, ease of syringe access, and receptive syringe sharing over different GF periods. However, given the ecological nature of this analysis, we cannot directly attribute these to either GF support or lack of such (Cepeda et al., 2019), demonstrated increases in the total number of syringes distributed by

NGOs during the GF period and reductions post withdrawal, supporting our findings. Similarly, our analyses do not demonstrate a direct causal relationship between each of the three outcomes. Rather, these show consistency between observed trends, which support our hypothesis. PWID in this sample might not represent all PWID in Tijuana, limiting the generalizability of our findings. Importantly, the majority were recruited in the Tijuana's "Zona Norte" where the drug market is concentrated, but the GF support led to substantial increases in NSP coverage in other areas in addition to the Zona Norte and therefore we might not have captured more extreme changes in other geographical areas.

It is worth mentioning that not all participants contributed equally to all the periods, but the loss to follow up was low. Finally, our analyses rely on self-reported behaviors and are subject to social desirability and imprecision due to recall. In particular, "difficulty in syringe access" represents a perception versus a fact and as such it is more subjective and prone to bias/inaccuracies, potentially explaining the weaker association found here. Despite this, study interviewers were highly experienced in interviewing PWID in Tijuana and created a trusting and non-judgmental environment, suggesting that social desirability may have been limited.

Next steps

While population and individual NSP coverage are associated with syringe sharing and HIV/HCV infection, local epidemic factors (Shaw, Shah, Jolly, & Wylie, 2007; Vickerman, Hickman, Rhodes, & Watts, 2006), including the background prevalence and incidence of infection among PWID, as well as contextual injecting behaviors shaped by structural factors, including the duration of injecting, the structure of injecting networks, injecting practices when reusing and sharing syringes (e.g., rising, bleaching), will also affect the effectiveness of NSP (Shaw et al., 2007; Vickerman et al., 2006). Similarly, several studies have shown that the combination of NSP and OST results in synergistic reductions in syringe sharing and bloodborne infection incidence. Examining these questions in the context of Tijuana will be important next steps to estimate and improve the effectiveness of NSP.

Our study provides strong evidence at the ecological level of a relationship between GF support, access to NSP, and receptive syringe sharing. Higher NSP access was mirrored by substantial reductions in receptive syringe sharing among PWID in Tijuana. However, as shown in our analysis, this reduction relies on the continuity of services and abrupt changes in funding can translate into sudden increases in syringe sharing, potentially facilitating HIV and/or HCV outbreaks. To be effective, harm reduction efforts require appropriate scale-up and sustainability and therefore coordinated efforts with local, state, and federal authorities

are needed to ensure the continuity of harm reduction coverage following donor aid withdrawal.

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Conflicts of interest

The authors declare they have no conflicts of interest.

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REFERENCES

- Aspinall, E. J., Nambiar, D., Goldberg, D. J., Hickman, M., Weir, A., Van Velzen, E., ... Hutchinson, S. J. (2014). Are needle and syringe programmes associated with a reduction in HIV transmission among people who inject drugs: A systematic review and meta-analysis. *International Journal of Epidemiology*, 43(1), 235-248. doi: 10.1093/ije/dyt243
- Bridge, J., Hunter, B. M., Albers, E., Cook, C., Guarinieri, M., Lazarus, J. V., ... Wolfe, D. (2016). The global fund to fight AIDS, Tuberculosis and Malaria's investments in harm reduction through the rounds-based funding model (2002-2014). *International Journal of Drug Policy*, 27, 132-137. doi: 10.1016/j.drugpo.2015.08.001
- Cepeda, J. A., Burgos, J. L., Kahn, J. G., Padilla, R., Meza Martinez, P. E., Segovia, L. A., ... Martin, N. K. (2019). Evaluating the impact of global fund withdrawal on needle and syringe provision, cost and use among people who inject drugs in Tijuana, Mexico: A costing analysis. *BMJ Open*, 9(1), e026298. doi: 10.1136/bmjopen-2018-026298
- Csete, J., Kamarulzaman, A., Kazatchkine, M., Altice, F., Balicki, M., Buxton, J., ... Beyrer, C. (2016). Public health and international drug policy. *The Lancet*, 387(10026), 1427-1480. doi: 10.1016/S0140-6736(16)00619-X
- Fernandes, R. M., Cary, M., Duarte, G., Jesus, G., Alarcão, J., Torre, C., ... Carneiro, A. V. (2017). Effectiveness of needle and syringe programmes in people who inject drugs—An overview of systematic reviews. *BMC Public Health*, 17(1), 309. doi: 10.1186/s12889-017-4210-2
- Kelley, M. S., Murphy, S., & Lune, H. (2001). A cultural impact of needle exchange: The role of safer-injection mentors. *Contemporary Drug Problems*, 28(3), 485-506. doi: 10.1177/009145090102800308
- Lopez Bernal, J., Cummins, S., & Gasparrini, A. (2017). Interrupted time series regression for the evaluation of public health interventions: A tutorial. *International Journal of Epidemiology*, 46(1), 348-355. doi: 10.1093/ije/dyw098
- PI: Stefanie Strathdee. (2010-2020). *Proyecto el Cuete phase IV: NIDA grant R01 DA0 19829*.
- Platt, L., Minozzi, S., Reed, J., Vickerman, P., Hagan, H., French, C., ... Hickman, M. (2017). Needle syringe programmes and opioid substitution therapy for preventing hepatitis C transmission in people who inject drugs. *Cochrane Database of Systematic Reviews*, (9), CD012021. doi: 10.1002/14651858.CD012021.pub2
- Robertson, A. M., Garfein, R. S., Wagner, K. D., Mehta, S. R., Magis-Rodriguez, C., Cuevas-Mota, J., ... Strathdee, S. A. (2014). Evaluating the impact of Mexico's drug policy reforms on people who inject drugs in Tijuana, BC, Mexico, and San Diego, CA, United States: A binational mixed methods research agenda. *Harm Reduction Journal*, 11(1), 4. doi: 10.1186/1477-7517-11-4
- Sawangjit, R., Khan, T. M., & Chaiyakunapruk, N. (2017). Effectiveness of pharmacy-based needle/syringe exchange programme for people who inject

- drugs: A systematic review and meta-analysis. *Addiction*, 112(2), 236-247. doi: 10.1111/add.13593
- Shaw, S. Y., Shah, L., Jolly, A. M., & Wylie, J. L. (2007). Determinants of injection drug user (IDU) syringe sharing: The relationship between availability of syringes and risk network member characteristics in Winnipeg, Canada. *Addiction*, 102(10), 1626-1635. doi: 10.1111/j.1360-0443.2007.01940.x
- Snead, J., Downing, M., Lorvick, J., Garcia, B., Thawley, R., Kegeles, S., & Edlin, B. R. (2003). Secondary syringe exchange among injection drug users. *Journal of Urban Health*, 80(2), 330-348. doi: 10.1093/jurban/jtg035
- Strathdee, S. A., Lozada, R., Ojeda, V. D., Pollini, R. A., Brouwer, K. C., Vera, A., ... Patterson, T. L. (2008). Differential effects of migration and deportation on HIV infection among male and female injection drug users in Tijuana, Mexico. *PLoS One*, 3(7), e2690. doi: 10.1371/journal.pone.0002690
- Strathdee, S. A., Lozada, R., Pollini, R. A., Brouwer, K. C., Mantsios, A., Abramovitz, D. A., ... Patterson, T. L. (2008). Individual, social, and environmental influences associated with HIV infection among injection drug users in Tijuana, Mexico. *Journal of Acquired Immune Deficiency Syndromes*, 47(3), 369-376. doi: 10.1097/QAI.0b013e318160d5ae
- Strathdee, S. A., Lozada, R., Martinez, G., Vera, A., Rusch, M., Nguyen, L., ... Patterson, T. L. (2011). Social and structural factors associated with HIV infection among female sex workers who inject drugs in the Mexico-US border region. *PLoS One*, 6(4), e19048. doi: 10.1371/journal.pone.0019048
- Vickerman, P., Hickman, M., Rhodes, T., & Watts, C. (2006). Model projections on the required coverage of syringe distribution to prevent HIV epidemics among injecting drug users. *JAIDS Journal of Acquired Immune Deficiency Syndromes*, 42(3), 355-361. doi: 10.1097/01.qai.0000219788.73539.47
- Wagner, A. K., Soumerai, S. B., Zhang, F., & Ross-Degnan, D. (2002). Segmented regression analysis of interrupted time series studies in medication use research. *Journal of Clinical Pharmacy and Therapeutics*, 27(4), 299-309. doi: 10.1046/j.1365-2710.2002.00430.x
- White, E. F., Garfein, R. S., Brouwer, K. C., Lozada, R., Ramos, R., Firestone-Cruz, M., ... Strathdee, S. A. (2007). Prevalence of hepatitis C virus and HIV infection among injection drug users in two Mexican cities bordering the US. *Salud Pública de México*, 49(3), 165-172. doi: 10.1590/S0036-36342007000300001
- WHO, UNODC, & UNAIDS. (2013). *WHO, UNODC, UNAIDS technical guide for countries to set targets for universal access to HIV prevention, treatment and care for injecting drug users – 2012 revision*. WHO, ISBN: 978 92 4 150437 9
- Wiessing, L., Ferri, M., Běláčková, V., Carrieri, P., Friedman, S. R., Folch, C., ... Griffiths, P. (2017). Monitoring quality and coverage of harm reduction services for people who use drugs: A consensus study. *Harm Reduction Journal*, 14(1), 19. doi: 10.1186/s12954-017-0141-6