UNDERSTANDING FACTORS ASSOCIATED WITH HIV INFECTIONS AMONGST FEMALE SEX WORKERS IN SOWETO

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I. DECLARATION

This thesis is presented in fulfilment of the requirements for the degree of Doctor of Philosophy (PhD) in the Department of Public Health at the University of Witwatersrand. The work on which this thesis is based is original research and neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university. The contents of this doctoral thesis are entirely the work of the candidate under the supervision of Professor Glenda E Gray and Professor Rachel Jewkes. Three published, peer-reviewed journal articles included in this thesis are directly based on research fulfilling the objectives of the research study for this degree as described in the Preface of this thesis. These works were co-authored by the candidate, supervisors, and research project team members; the role of each author for each paper is described at the introduction of each chapter (4-8) in this thesis.

Signature:  Date: 2 May 2018

To my two wonderful children. Be brave, be gentle, be strong.

Graeme, thank you for being the gentle man that you are. I love walking this path with you.

For Granny Mu, who taught me to love.

II. ACKNOWLEDGEMENT

To my parents, thank you for instilling in my an insatiable curiosity. I think that I may well be the elephant's child.

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IV. PREFACE

This doctoral thesis includes work presented in peer-reviewed publications as per general provision 6.7 in the General Rules for the Degree of Doctor of Philosophy (PhD) of the University of Witwatersrand. The submission of the thesis in this format was approved by Professors Glenda E Gray and Rachel Jewkes on 01 November 2017. The publications included in this thesis all relate directly to my thesis topic, and contribute to answering the aims and objectives as outlined in this study. The following publications are included in this thesis:

Table IV-1: A list of publications by chapter as included in this thesis

THESIS CHAPTER	PUBLICATION CITATION
Chapter 4	Coetzee, J., Gray, G.E., & Jewkes, R., (2017) Prevalence and patterns of victimization and poly-victimization amongst female sex workers in Soweto, a South African township: A cross sectional, respondent driven sampling study. (Global Health Action).
Chapter 5	Coetzee, J., Buckley, J., Otwombe, K., Gray, G.E., & Jewkes, R., (in press) Depression and post-traumatic stress amongst female sex workers in Soweto: prevalence and risk factors. A respondent driven sampling study (PlosOne)
Chapter 6	Coetzee, J., Jewkes, R., & Gray, G.E., (2017). Cross-sectional study of female sex workers in Soweto, South Africa: factors associated with HIV infection. Plos One.
Chapter 7	Coetzee, J, Hunt, G, Jaffer, M, Otwombe, K, Scott, L, Bongwe, A, Ledwaba J, Molema, S, Jewkes, R, & Gray, G.E (2017). HIV-1 viral infectivity and drug resistance amongst female sex workers in Soweto, South Africa: A cross sectional study (PlosOne)
Chapter 8	Coetzee, J., Gray, G. E., & Jewkes, R., (draft) Understanding the complexity of HIV infection amongst female sex workers in Soweto: A structural equation model (The Lancet)

I am the lead author on all published papers included in this thesis and my supervisors are listed as co-authors on these papers because of their contributions to them; this is the common practice in health sciences publications. For the publication included herein as chapters 3-6, additional co-

authors were included because they were co-investigators on the larger project from which the data were extracted and they provided reviews of advanced drafts of the paper before submission for publication. The candidate designed, raised funds for and implemented the project with almost exclusive independence of her supervisors. She conducted all analyses and wrote each draft of every manuscript with minimal input from either supervisor or co-authors. Each publication conforms to the style required by the respective journal and book and are presented in these formats within this thesis. The reference style for all chapters is a consistent Plos format or as required by the publishing journal.

IIV. SUPERVISION OF THIS STUDY

Both Professors Glenda E Gray and Professor Rachel Jewkes have provided supervision from the beginning of the thesis work in 2014 until its conclusion in 2017. The inclusion of two supervisors has ensured that the conceptualisation and methodology of the overall thesis and each individual chapter was sound and that the papers were written clearly and were academically appropriate. I discussed the overall design of the study, secured all funding, and both collected and oversaw data collection under the guidance of my two supervisors. I also discussed my concept for the thesis and each chapter and the data analysis for each chapter with my supervisors. I drafted each paper in full before submitting the draft to my supervisors for their review. All revisions resulting from their review and the peer review processes for publication were made by me. The supervisors also approved the final draft of each manuscript before submission for peer reviewed publication.

IIIV. EXECUTIVE SUMMARY

South Africa has the highest prevalence of HIV in the world, yet little is known about factors driving the epidemic amongst key affected population, such as sex workers (SWs). In South Africa, SWs

have been shown to have an HIV prevalence ranging from 36-89%, however there is no evidence to show the prevalence of HIV drug resistance in this population. They are known to be exposed to high levels of violence perpetrated by clients and policing officials. Despite their trauma exposure, very little is known about their mental health, and no research exists which explains the complex interconnections of all of these factors on HIV prevalence in this population. South Africa is in the process of scaling up a National Sex Worker HIV Plan. This makes it important that research begin to describe previously undocumented SW populations, such as that in Soweto.

Through drawing on an ecological model of vulnerability, the study aimed to a) describe the prevalence of violence by perpetrator category and violence type, as well as patterns of victimization and polyvictimization, b) understand the prevalence of both depression and PTSD as well as associated factors; c) estimate HIV prevalence, and further describe sexual risk factors and their association with HIV vulnerability; d) describe the prevalence of HIVDR mutations; and e) model the complex relationships between violence and mental health upon HIV infection, for female sex workers (FSWs) in Soweto.

In doing so a respondent driven sampling methodology was used to recruit 508 FSWs. Drawing from a chain referral method, and including an estimate of relative network size, the methodology enabled the estimation of population level prevalence. Data was collected using a comprehensive survey, HIV rapid tests, CD4 count, viral load, and HIV drug resistance mutations tests for those testing HIV positive. All data were live captured into the REDCap online data management system. Univariate, bivariate and multivariate analyses were conducted using STATA-15, RDS-Analyst and RDSAT.

The median age of FSWs in Soweto was 31 years, and most had an incomplete education (74.2%). The prevalence of exposure to physical/sexual intimate partner violence (IPV), in the past year was 53.8%, 46.8% by clients, and 18.5% by police. Past year prevalence of sexual/physical violence by

any perpetrator category was 70.8% and lifetime exposure was 76.0%. Childhood sexual violence was reported by 44.3% of the women. Lifetime non-partner rape was 55.5% and all rape exposure was 62.4%. As a result of engaging in sex work in the past year, 65.2% of women reported being discriminated against. Client, police, IPV, and childhood trauma were all significantly associated with one another, with IPV being the most common co-occurrence. Polyvictimization was seen in almost two thirds of FSWs, and increased with exposure to discrimination.

Symptoms of severe depression were prevalent amongst 68.7%, PTSD was 39.6%, and 32.7% suffered from comorbid PTSD and depression. Experiencing ≥3 kinds of violence increased the likelihood of comorbidity (RRR 4.1, 95% CI 1.5-11.1,p=0.005). Internalised stigma increased the likelihood of one mental health condition (RRR 1.3, 95% CI 1.1-1.4,p=0.001), higher self-esteem was associated with both independent (RRR 1.1, 95% CI 1.1-1.3, p=0.002) and comorbid mental health conditions (RRR 1.2, 95% CI 1.1-1.3, p=0.001).

HIV prevalence among FSWs was 53.6% (95% CI 47.5–59.9). FSWs were almost exclusively based in taverns (85.6%) and hostels (52.0%). Advancing age, incomplete secondary schooling, migrancy and multiple clients increased the likelihood of HIV acquisition: >30 years of age was associated with a 4.9 times (95% CI 2.6–9.3) increased likelihood of HIV; incomplete secondary schooling almost tripled the likelihood (AOR 2.8, 95% CI 1.6–5.0); being born outside of the Gauteng province increased the likelihood of HIV by 2.3 times (95% CI 1.3–4.0); and having more than five clients per day almost doubled the likelihood (AOR 1.9, 95% CI 1.1–3.2).

Among the HIV positive, 51.8% (141/269) were defined as virologically suppressed (VL < 400 copies/ml). Of the 119 individuals with unsuppressed viral loads who were successfully genotyped for resistance testing 37.8% (45/119) had detectable drug resistance. In this group, HIVDR mutations were found amongst 73.7% (14/19) of individuals on treatment, 27.4% (26/95) of individuals who were treatment naïve, and 100% (5/5) of defaulters. One phylogenetic cluster was found amongst

treatment naïve FSWs. The K103N mutation was detected most commonly in 68.9% (31/45) individuals with HIVDR mutations, with 20/26 (76.9%) of treatment naïve FSW with detectable resistance having this mutation. The M184V mutation was found in both FSWs on treatment (12/14, 85.7%) and those defaulting (1/5, 20.0%).

The median age of FSWs in Soweto was 30 years, with only 16 cross-border migrants (Table 2). More than half were Zulu speaking (53.9%) and the remainder were SeSotho speaking or spoke other languages (25.8% and 20.3%, respectively). The majority of FSWs had an incomplete education (384, 75.6%), had sold sex for the first time at age 25 (6-48), and were born in Gauteng (346, 68.1%). The median score for childhood trauma was 18 (12-34) and 56.9% had had more than 5 clients the last day that they had sold sex (n=289). More than half (280, 55.3%) were HIV positive. Overall, three quarters (381, 75.1%) engaged in binge drinking, with the median score being 10 (0-17). Most FSWs had a low or moderate self-esteem, with the median being 11 (3-19), and more than one-third of FSWs had symptoms indicative of PTSD (per the DMS-IV diagnostic criteria), with a median PTSD score of 18 (8-31). Internalised stigma was reported by 72.6% (369) of FSWs, and the median was 14 (8-25), while 68.5% (348) experienced discrimination, with a median score of 9 (7-25). Past year intimate partner violence was reported by 56.7% (n=288, MED, IQR 12, 8-33), past year police violence was reported by 10.4% (n=53, MED, IQR 4, 4-13), and past year client violence was reported by 52.2% (n=265, MED, IQR 5, 4-16).

Table 2 also shows that HIV status was associated with higher binge drinking scores (8.8, 95% CI 8.3-9.4, p=0.05), a moderate-low self-esteem score (11.1, 95% CI 10.7-11.5, p= 0.06), and more experiences of discrimination (9.3, 95% CI 9.0-9.6, p=0.016). Experience of police and client violence was associated with being HIV positive (4.3, 95% CI 4.2-4.4, p=0.024, and 6.1, 95% CI 5.7-6.4, p=0.056, respectively) as compared with HIV negative. Almost two-thirds of FSWs with an incomplete education were HIV positive (234, 60.9%, p=<0.0001) when compared to HIV negative, where 40% had an incomplete education (150, p=<0.0001). The median age of first selling sex was older amongst HIV positive FSWs than HIV negative FSWs (26.5, 95% CI 25.7-27.3 versus 24.3, 95% CI 23.4-25.2, p=0.0002). There were more HIV positive FSWs who were born outside of Gauteng Province as compared with HIV negative FSWs born outside of the province (108, 38.5% versus 54, 23.7%, p=<0.0001). Childhood trauma scores were higher amongst FSWs who were HIV positive as compared to those who were negative (p=0.0041), and 61.8% of HIV positive FSWs had more than 5 clients in the last working day (173, p=0.014) compared with 49% of HIV negative FSWs.

As shown in Table 3 and Figure 1, the model has 5 exogenous variables and four of the five had direct pathways to HIV. These four were increasing age of entry into sex work, (incomplete) education, being born outside of the Gauteng Province (and having more than 5 clients per day. Three pathways connected child abuse and HIV, all mediated by violence exposure. The first had a single mediating variable, which was a latent variable for violence exposure, in the path between childhood abuse experience and HIV, such that women with higher levels of childhood abuse had a greater vulnerability to violence by intimate partners, client or police, or discrimination, leading to a greater likelihood of being HIV positive. The second pathway between childhood abuse and HIV was mediated by violence experience, PTSD, self-esteem, binge drinking and number of clients. A third pathway was very similar to this, but instead of being mediated by PTSD, this was mediated by internalized stigma. There were indirect pathways between number of clients and HIV and between age of entry into SW and HIV. In each case the paths were mediated by internalized stigma, self-esteem, binge drinking and the number of clients.

In Soweto, FSWs are exposed to high rates of violence in multiple forms across their lifetime. Our findings show that violence continues unabated into adulthood at levels far higher than in the general population and overall at higher levels than previously recorded amongst SWs in South Africa. We argue that violence against FSWs is rooted in discrimination. The disparate burden of violence on FSWs requires urgent interventions to proactively address and reframe the normalisation of violence against all women. Key Words: sex work, South Africa, violence, client violence, intimate partner violence, hate crime

There is a sizable burden of treatable mental health conditions among FSWs in Soweto. This was driven by multiple exposures to violence, sex work related discrimination and overall moderate levels of self-esteem masking defence mechanisms. This suggests the urgent need to design and integrate services geared to the mental health needs for this population.

There is also an extreme vulnerability of FSWs to HIV. Advancing age, limited education and multiple clients were risk factors associated with HIV, strongly driven by a combination of structural, biological and behavioral determinants. Evidence suggests that interventions need to be carefully tailored to the varying profiles of SW populations across South Africa. Soweto could be considered a microcosm of South Africa in terms of the epidemic of violence and HIV experienced by the SW population, which is influenced by factors often beyond the individual level of control. While describing a hitherto largely undocumented population of FSWs, our findings confirm the urgent need to scale up innovative HIV prevention and treatment programs for this population.

More than one third (45/119) of the genotyped sample had HIVDR, with resistance to the NNRTI class being the most common. Almost half of HIV positive FSWs had unsuppressed viral loads, increasing the likelihood for onward transmission of HIV. Disturbingly, more than 1:4 treatment naïve women with unsuppressed viral loads had HIVDR suggesting that possible sexual transmission of drug resistance is occurring in this high-risk population. Given the high burden of HIVDR in a population with a high background prevalence of HIV, it is imperative that routine monitoring of HIVDR be implemented. Understanding transmission dynamics of HIVDR in FSW and its impact on treatment success should be urgently elucidated.

Building on previous research on structural drivers, sexually risky behaviour, violence, mental health and HIV, our study provides strong evidence of the causal pathways among FSW linking their vulnerability to HIV. We have shown the importance of a multi-layered understanding of FSWs' vulnerability to HIV, and the complexity of intersecting pathways. The South African National Sex Work HIV Plan is underpinned by a biomedical and behavioural foci on HIV prevention with limited scope to drive mental health and violence as key components of SW vulnerability to HIV. This means that in terms of a vulnerability continuum, the focus of interventions is being placed at the tail end of vulnerability rather than earlier in the continuum, which would likely yield more sustainable

results. This highlights the urgent need to diversify service offerings to meet the needs of the population rather than focus largely on sexual risk behaviours and treatment options for HIV prevention. Without more complex understandings of HIV vulnerability, it is impossible to fully appreciate the policy and practice interventions required. Thus South Africa will continue its burgeoning HIV epidemic and our prevention and treatment interventions are likely to have limited effect. Through developing a more nuanced and complex understanding of vulnerability in key affected populations, we can clearly see the role of mental health and violence as they impact upon the HIV epidemic. It is critical that the South African Government understand that violence and resulting, unaddressed trauma-related needs are likely hampering our HIV prevention and treatment efforts [1, 2]. In addressing violence, it should also be noted that research to understand mechanisms to engage paying and non-paying partners of SWs needs to urgently be undertaken. The lack of male inclusion in sex work programs is an oversight and inhibits the ability to engage in gender transformative interventions to improve gender equality, a key driver of violence perpetration [3]. Thus, these findings highlight plausible reasons why the current HIV focus is and will continue to fail SWs. These findings support a change in the immediate HIV policy and funder environment with a view beyond the immediate HIV focus and to include strong mental health and violence prevention and treatment interventions as equally important components in the HIV armory.

IX. ACRONYMS

ADR	Acquired drug resistance
AIDS	Acquired immune deficiency syndrome
ART	Antiretroviral treatment
ARV	Anti-retrovirals
CDC	Centre for Disease Control and Prevention
CI	Confidence Interval
DOH	Department of Health
FSW	Female Sex Workers
GBV	Gender Based Violence
HIV	Human immunodeficiency virus
HIVDR	HIV drug resistance
HTS	HIV Testing Services
IPV	Intimate partner violence
LDTD	Long-distance Truck Drivers
M&E	Monitoring and Evaluation
MSM	Men who have sex with men
NSWP	National Sex Worker HIV Program
PHRU	Perinatal HIV Research Unit
PMTCT	Prevention of mother-to-child transmission of HIV
RDS	Respondent Driven Sampling
SAHMS	South African Health Monitoring Survey
SANAC	South African National AIDS Council
SRH	Sexual and reproductive health
SSA	Sub Saharan Africa
SSWP	Soweto Sex Work Programme
SW(s)	Sex Worker(s)
SWEAT	Sex Workers Education and Advocacy Taskforce
TDR	Transmitted drug resistance
UNAIDS	Joint United Nations Program on HIV/AIDS

VL	Viral load
WHO	World Health Organization

1. CHAPTER ONE: INTRODUCTION

1.1. SEX WORK

Globally, sex workers (SWs) bear a disproportionate HIV burden [4]. Despite South Africa entering its 5th decade of HIV, very little is understood about the determinants of HIV acquisition amongst female sex workers (FSWs). The United Nations defines sex work as adults "who [voluntarily] receive money or goods in exchange for sexual services either regularly or occasionally" [5]. Previous definitions have included that it is "any agreement between two or more persons in which the objective is exclusively limited to the sexual act and ends with that"[6]. Under the Sexual Offence's Act, No. 23 of 1957 and the Sexual Offences Amendment Act, No. 32 of 2007, sex work in South Africa is criminalised [7, 8]. This includes the buying, selling and living off the proceeds of sex work. Sex workers can be female, male or transgender adults.

The boundaries of sex work are ambiguous with ranges in the formality of the profession, frequency of work, and activities undertaken varying [9]. Sex work can be defined in a multitude of ways including by venue (brothel-, hotel-, street-, or tavern-based) or by frequency (full- or part-time). It can be formal such as a commercial sex work, or informal which includes individuals who may not self-identify as SWs and who sell sex irregularly. Sex workers can work as independent agents, for an institution (brothel), or a pimp/manager.

In sub Saharan Africa, a nuanced approach to defining sex work is required given the varying cultural, contextual and socioeconomic factors impacting upon the profession and how it is framed by the community. Sex work in South Africa fits within discourses surrounding the exchange of money-for-sex. However it varies greatly in aligning with culturally appropriate norms in the country and to mitigate the risk of discrimination and violence[10]. It can be useful to consider SW on a continuum (Figure 1-1), from commercial sex work through to less formalised transactional sex. This

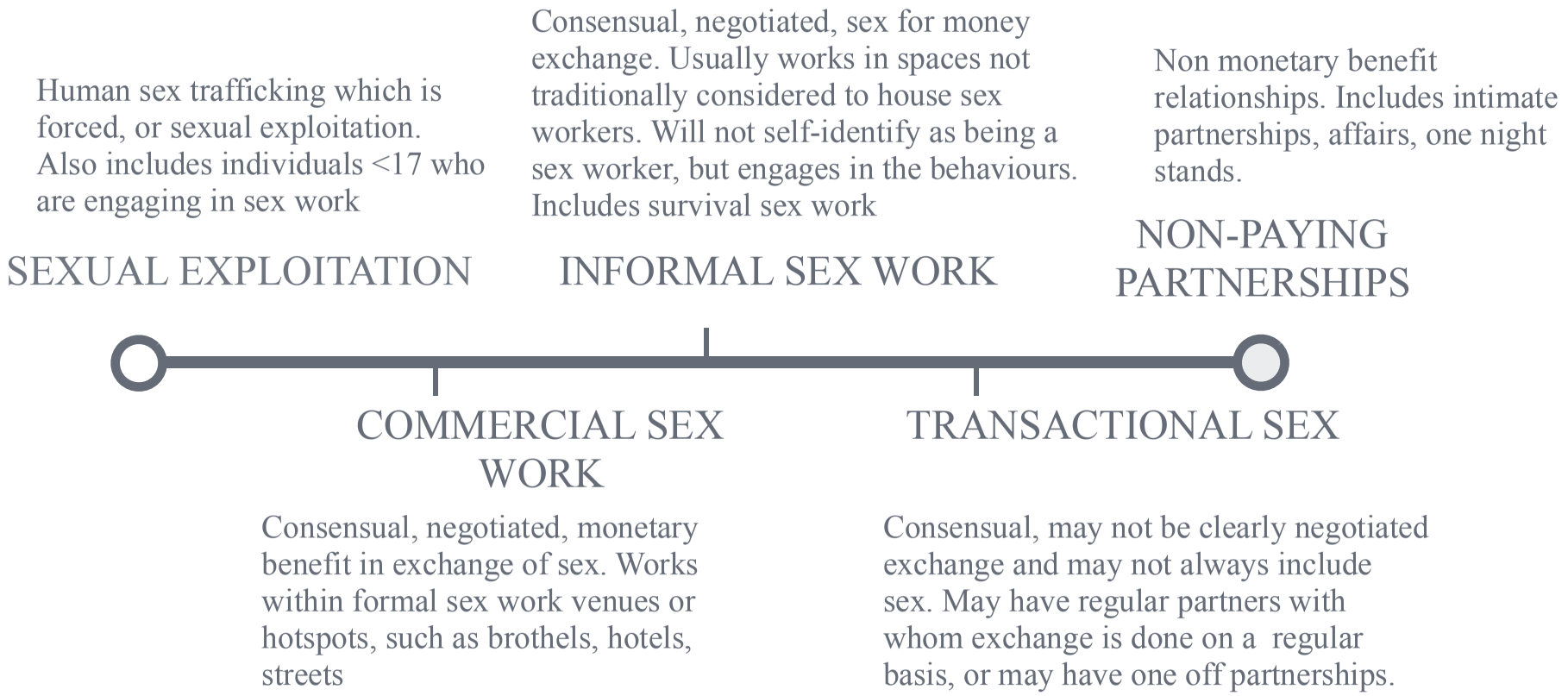

Figure 1-1: Sex work in South Africa can best be understood on a sliding scale of behaviour and self-identification

enables greater variability in the profession and guidance for public health programs that need to be adaptable in providing services to a spectrum of persons engaging in the sale of sexual services.

Direct or commercial sex work primarily centres on the negotiated exchange of sex for money or goods. This may include individuals who work in various contexts including on streets or in brothels. Sex workers may actively seek their clients through frequenting male-dominated venues such as taverns (informal drinking establishments) or taxi ranks [9, 11].

Indirect or informal sex work is not necessarily cantered on sex-for-money as a commercial venture, and may not be the primary source of income[9, 12]. Activities can include sex for beer and survival sex work. In summary, these activities may not be considered to conform to western notions of sex work and individuals engaging in informal sex work may not self-identify as SWs. Consequently, their risk profile is not necessarily self-recognised, posing a potential health risk.

In Soweto, the term *Ukuphandha* was documented in relation to women who engage in sex-for-money exchanges beyond the formalised commercial sex work enterprises seen in Hillbrow [10]. In segregating themselves from commercial SWs, township women are able to align themselves with normative cultural and sexual practices, and minimise discrimination [10, 13]. Through engaging in elaborate forms of denial, such as not referring directly to engaging in 'sex work', research has shown that some women who sell sex were able to retain a sense of respectability [13]. Despite this, the behaviours and practices that they engage in align with public health conceptualisations of sex work and their sexual risk profile is likely to be the same. However, little is known about the epidemiology of HIV in this category of SW.

1.1.1. POPULATION SIZE ESTIMATION

Several estimates have been made of the number of SWs in South Africa. In 2008, it was suggested that there were 1,200 SWs in Cape Town, with 250 of these being street-based and the remainder

were indoor-based [14]. In 2013 the Sex Workers Education and Advocacy Taskforce (SWEAT) released the results from a rapid size estimation study based on the "wisdom of the crowd" methodology [15]. Various assumptions guided four estimation models which ranged from a conservative underestimate to an overestimate. The third estimate was considered by the SANAC Sex Work Technical Working Group to be the most realistic representation of the number of SWs across South Africa.

SWEAT estimated that the total number of adult SWs in South Africa was 150,029 (131,875 – 262,534). Female sex workers dominate this, with 137,643 (120,986 - 240,859) estimated to live in the country, equating to 0.87% of the total adult female population in South Africa. Furthermore, 5% (6,882, 6,049 - 12,043) of SWs in South Africa were thought to be male and 4% (5,506, 4,839 – 9,634) were transgender. The same study, suggested that 22% of FSWs resided in the Gauteng province, which equated to 29,733 women. This size estimation exercise was the first comprehensive estimation to have been undertaken across South Africa. They concluded that SWs were concentrated in urban areas, over rural areas [15]. More recent estimates from the SAHMS for Johannesburg, Gauteng suggest that there are 7,697 FSWs (95% CI 5,000 - 10,895) in the greater Johannesburg area [16]. Currently no estimated exist by venue split of SWs.

In understanding SW concentration per venue type, 1 Kenyan study attempted to calculate the number of SWs per venue, publishing a map of Nairobi showing their findings [17], however for ethical reasons, the map was retracted in 2015. The study captured 137 hotspots with a total of 3,070 SWs being counted on day one of the capture-recapture method, and 2,901 on the second capture day. Findings show the most popular venue to sell sex in Nairobi was bars (59%), streets (23.6%) and hotels (14.9%). In South Africa, the SAHMS estimated that the most popular venues for SWs to sell sex in Johannesburg, Cape Town and Durban were streets, parking lots or other public spaces (>

61.0%), and bars, café's or nightclubs (>32.5%). In both Johannesburg and Durban, brothels or hotels (>13.5%) were also popular [16].

Findings also showed the popularity of truck stops for the sale of sexual services. Several studies have shown the sexual interactions between long-distance truck drivers (LDTD) and SWs globally [18-21]. All have highlighted the increased risk of HIV for both SW and truck driver. In South Africa, a Respondent Driven Sampling (RDS) study recruited FSWs along the N3, a major trucking corridor between KwaZulu Natal and the Free State (n=173 FSWs, n=518 LDTD). Findings showed that 88.4% of FSWs were HIV positive while only 16.7% of LDTD were infected [18]. A 2002 cross-sectional study in KwaZulu Natal (n=320) found that 56% of LDTD were HIV infected [21].

1.2. DEMOGRAPHIC CHARACTERISTICS

Evidence from 2008, in Cape Town suggests that most SWs were black South Africans aged between 24-28 years [14]. By comparison, the 2013 SAHMS found that more than a third of SWs in Cape Town were Coloured (persons in South Africa with a mixed-heritage, including Cape Malay descendants) and South African. The same study showed that in Johannesburg, almost all FSWs were Black African and largely cross boarder migrants. Secondary school education showed better outcomes in Cape Town, where only 40% had an incomplete education, by comparison, almost 75% in Johannesburg had not completed their secondary school education. In both metropolitan areas, more than half were married or cohabiting [16].

1.3. TRANSACTIONAL SEX

The differentiation between sex work and transactional sex can be difficult to make, and few women who engage in the latter would identify themselves as engaging in sex work [10-12, 22-25]. Transactional sex has widely been described in the literature and it is generally agreed to involve the material exchange of money, food, cosmetics, transportation or other goods in light of sexual gain[22, 26-28]. However, the nature of this relationship has been defined in different ways. It has

been argued that the exchange should be considered to be a relationship with a regular partner [29]. Within this context, the gift exchange often forms part of a broader set of responsibilities within that relationship. This enables a socially acceptable, extra-marital relationship whereby gifts are bestowed upon an individual who could be positioned as a "boyfriend" or "girlfriend" [23, 30]. Further, such interactions are based upon narratives of socially normative and often affectionate relationships, with sex being a normal but not obligatory outcome[30]. Researchers have described transactional sex as evolving out of traditional African culture that embraces sexuality, and the resultant practices such as *Labola*, or bride price, result in the commoditisation of women's sexuality. It is further argued that sex services were regarded as being as normal as work, eating or drinking. Similarly, they were met with reciprocal exchanges of goods or services, both inside and outside of marriages. In this way, there was always been some transactional element to sex, in African culture [31]. Dunkle et al[22] however, argues that while *Labola* includes a formal negotiation and exchange between families, transactional sex is far from formal in its negotiations between either parties or their families. Studies have suggested that the motivation behind transactional relationships are complex and may be driven by survival needs [26, 32] or an increase in materialism [30, 32]. However it is defined, recent studies have agreed that women are motivated through such transactions to have sex in situations where they otherwise may not have [22, 23, 25, 33]. This increases their risk of HIV, exposure to violence and sexual exploitation [22, 26, 34]. Additionally, evidence suggests that, transactional sex provides income for many women of low socio-economic status [30].

The links between transactional sex and HIV have been documented. A cohort of young women in the Stepping Stones Trial were found to have an increased risk of HIV by engagement in transactional sex with casual and main partners [35]. Adolescent young women in Rural South Africa had a 2.5 times greater risk of HIV if they transacted in sex [36]. Transactional sex has been also been documented in Soweto, South Africa [10, 26]. A study of 1395 women attending antenatal

clinics in the Township highlighted that 21% of participants self-reported ever engaging in such a relationship. The majority of these (89%) were with a regular partner[26]. A 2002 study described transactional sex-for-money exchanges taking place in Soweto, confirming that such exchanges were informal and ambiguous in comparison to commercial sex work. The study highlighted that these exchanges served largely as a means of survival for some women [26].

As can be seen, a clear-cut distinction between informal sex work, such as that seen in Soweto, and transactional sex, as described both in Soweto and across the African continent, is hard to make. For the purposes of this study, we have focused on women who engage in both commercial and informal sex work, as a primary means of earning money.

1.4. HUMAN SEX TRAFFICKING & CHILD PROSTITUTION

Sex work also differs from human sex trafficking, which is defined by the United Nations[37] as

> "the recruitment, transportation, transfer, harbouring or receipt of persons, by means of the threat or use of force or other forms of coercion, of abduction, of fraud, of deception, of the abuse of power or of a position of vulnerability or of the giving or receiving of payments or benefits to achieve the consent of a person having control over another person, for the purpose of exploitation".

Travel or migration for the purposes of selling sex is not voluntary during trafficking[9]. In the absence of rigorous National-level data, estimates suggest a bleak picture. The majority of victims of trafficking are thought to be girls and women (11.4 million, 55%), with an estimated 22% being exploited for sex, and 26% being under the age of 17 years. Of those trafficked, a total of 3.7 million are thought to be in Africa in 2011 [38]. A 2012 International Labour Organisation reports estimated that 4/1,000 Africans are trafficking annually [38]. A 2012 International Organisation for Migration report noted that only 12% of individuals trafficked in South Africa are for sexual exploitation, with

forced labour being the primary reason for trafficking[39]. However, between 2005-2006, 66 victims of sex trafficking were assisted in South Africa[40]. Such information suggests that monitoring and estimating the number of victims of human sex trafficking is complex.

Childhood prostitution is a further term used to describe individuals who are voluntarily selling sex, but are aged 16-18 years. Such persons are considered by the Sex Work Sector to be sexually exploited. While recent evidence suggests that between 8.2%-27.2% of FSWs in South Africa sold sex before they were 18[16], little else is known about this sub-population which is largely excluded from research in South Africa due to ethical concerns.

1.5. SEX WORK IN SOWETO

Soweto is a township South East of Johannesburg, South Africa's largest metropolitan city. The township evolved in response to the discovery of gold, while being shaped by South Africa's punitive apartheid laws governing the movement of people and land ownership. The area was demarcated for Black South Africans, and includes 11 hostels built to house the male mining workforce, and heavily tied-up in Apartheid's urban African policies surrounding segregation. The accommodation comprised the bare minimum: single-story blocks of one-roomed, male-only housing, frequently without running water, no electricity, and no toilets [41]. They were also segregated by ethnic groupings and toward the end of Apartheid, became centres of political unrest and violence in Soweto. During apartheid, residents of Soweto were considered to be temporary dwellers, they were there only to service the Johannesburg demand for a cheap, black, male workforce. Within this context, there was limited demand for a female workforce, and sex work within Soweto is likely to have begun in response to the need for economic survival within a poor 'black' and male dominated township by disenfranchised women.

However, limited information is available on sex work within township settings, a prominent feature of South Africa's urban and peri-urban landscape. A convenience sample of 53 women were

qualitatively interviewed on their engagement in "survival sex" in Hamanskraal and Soweto between 1999-2000 [12]. Wojcicki highlights the importance of contextual understanding when considering sex-for-money transactions, and the role which sex plays in the economic sustainability of women. Participants reflected on the absence of commercial sex work in both townships, and reflect common notions of SWs as dressing provocatively which would be dangerous in a township setting. The participants distanced themselves from sex work through multiple mechanisms, including their dress code and negotiation of both services. Interestingly, the negotiation of payment is less formal in township settings, where earnings also appeared to be lower than those for commercial SWs. Findings suggested that sex work and survival sex are fundamentally different, and that this has important implications for to HIV or violence prevention interventions [12].

The township of Soweto has evolved to be a predominantly urban and peri-urban, low-income township with limited educational and employment opportunities. It has the highest population density in South Africa, comprising more than 40 suburbs within 61km2, and is estimated to house over two million inhabitants. Soweto has approximately 3,000 drinking establishments (legal and illegal), known as taverns or shebeens. Annually, R50 million (USD 3.8 million) is spent on beer in Soweto. Within the township there now an estimated 40,000 residents living across the 11 former-mining hostels and given the politicised and violent history of these living quarters, hostel dwellers have never fully integrated into suburban, township life [42]. Despite encouraging family units to move into the hostels post-apartheid, they remained a source of unrest and crime owing to serious overcrowding, poverty and South Africa's complex socio-political history. These hostels comprise a highly patriarchal environment, valuing an African culture of hegemonic masculinity aimed at the subordination of women [43], giving rise to high levels of violence [12, 33]. It is from within these hostel and tavern environments in Soweto that sex work now takes place.

SSWP 2013-2015 data suggested that SWs in Soweto who accessed the programs services were predominantly female, with a median age of 37 years (ranging from 18-69 years). Serious HIV related health concerns were highlighted, with 96% of SWs testing for HIV, 42% being HIV positive and of these only 15% were undertaking a CD4 count. The outreach data consistently highlighted that antiretroviral treatment (ART) defaulting was high, concerns with accessing legal termination of pregnancy and poor health literacy were also regularly reported by program staff. Exposure to violence and resulting mental health concerns were flagged as an area of concern and there was a high demand for psychosocial counselling. Together these factors translated into poor healthcare access, possible ART drug resistance and an urgent need to scale up HIV and violence prevention programs. This situation was compounded by an environment that encouraged high exposure to violence and alcohol in taverns and hostels, but with low social capital and poor psychosocial support systems available to SWs in Soweto. Based on preliminary programmatic data, data from the Gauteng province, and the existing literature [16], we believed that the HIV prevalence among SWs in Soweto would be ~60%. Further data was required to better understand the factors associated with HIV status amongst this population. This would allow for improved tailoring of treatment and prevention components of the SSWP intervention.

In understanding SW vulnerability to HIV, it is critical that we begin to understand the impact of various bio-behavioural, structural and psychosocial factors which drive the epidemic, and which have not previously been clearly outlines amongst the Soweto sex work population. This thesis is geared to developing an understanding of the factors associated with HIV infection for SWs who live and work within a township that has an interesting socio-political history. Furthermore, the study will provide population level prevalence estimated of not only HIV infection amongst these women, but also their exposure to the sexual acquisition of HIV drug resistance (HIVDR), prevalence of violence across their lifetime and by different partner types, as well as the risk of mental health conditions such as Major Depression or Post Traumatic Stress Disorder (PTSD).

1.6. AIMS & OBJECTIVES

The study aimed to ascertain the burden of HIV, violence exposure and mental health amongst FSWs in Soweto, South Africa, and to further describe associated psychosocial, behavioural and economic factors in order to inform the development of a comprehensive prevention and treatment program. In doing so, the study objectives were:

Objective #1: To describe the prevalence of violence by perpetrator category and violence type, as well as patterns of victimisation and polyvictimization, amongst FSWs in Soweto, South Africa. **Hypothesis:** Exposure to violence would be substantially higher amongst FSWs than women within the general population in South Africa. Violence would also co-occur across their lifetimes.

Objective #2: To understand the prevalence of both depression and PTSD as well as associated factors amongst FSWs in Soweto, South Africa. **Hypothesis**: major depression and PTSD would be prevalent within this population at levels higher than the general population.

Objective #3: To estimate HIV prevalence among FSWs within Soweto, and to further describe sexual risk factors and their association with HIV vulnerability in this population. **Hypothesis:** That HIV prevalence would be lower than found in 55-60%, and that many of the factors associated with it would be linked to structural level concerns in South Africa

Objective #4: To describe the prevalence of HIVDR mutations amongst a sample of FSWs from Soweto, South Africa. **Hypothesis:** That there would be levels of HIV drug resistance in this population which would be higher than within the general population.

Objective #5: To model the complex relationships between violence and mental health upon HIV infection amongst female sex workers in Soweto. **Hypothesis**: Vulnerability to HIV would result from complex interactions between mental health and violence.

In outlining the study, Chapter Two will provide a comprehensive background of all factors associated with sex work and HIV, both globally and locally. Furthermore, factors which have, to date, been under-researched within this specific population will be expanded upon, in arguing for a holistic and human rights approach to interventions geared to SWs in South Africa. The thesis aims to contribute knowledge from South Africa to the growing body of evidence on SW vulnerability and exposure to HIV, drug resistance, violence, and mental health concerns. Furthermore, to profile a previously relatively undocumented subset of women who engage in the sale of sexual services within the informal sex work environment which is growing in Soweto, a South African township.

To date, there are a few critical gaps in knowledge, for which this thesis aims to build knowledge. For example, no prevalence for the sex work community in Soweto had been calculated for HIV, violence concerns have been documented in South Africa but not consistently and never across the lifespan of sex workers. There was a serious paucity in mental health knowledge about this population. Only two mental health papers were found during intensive literature searches which included multiple databases: Google Scholar, Science Direct, PubMed, Tailor and Francis, Sage, EbscoHost and PsychInfo. In addition, there was a global dearth in evidence on HIVDR amongst this marginalised population. This despite widespread agreement of heightened HIV vulnerability amongst SWs, and that treatment defaulting was regularly experienced by SWs in South Africa for various reasons including police harassment and overall exposure to violence. While the South African National Sex Worker HIV Plan is grounded in the dual HIV-violence epidemics, the scale up of services to SWs is an opportunity for South Africa to lead in providing comprehensive physical and mental health services to SWs. The research highlights the need for greater tailoring of programmes which address the overall needs of SWs and which are not only tailored to the HIV epidemic in South Africa. It also highlights how the verticalisation of healthcare services delivery to SWs through HIV mechanisms has limited the ability of service providers to comprehensively assist these individuals.

Following on from the background of this thesis, Chapter Three will detail the Respondent Driven Sampling (RDS) methodology which was used to access this hard-to-reach population, while also allowing for population level estimated to be generated from the data. Innovatively, the methodology was implemented using a strong community collaboration which ensured that SWs or former SWs were sufficiently, professionally capacitated enabling them to gather the study data. Thus, this thesis enabled the empowerment of a community in a fashion which is sustainable and allows them to actively participate in knowledge generation about sex work.

Chapter Four of this thesis presents paper one, which is titled: Prevalence and patterns of victimisation and poly-victimisation amongst female sex workers in Soweto, a South African township: A cross sectional, respondent driven sampling study. In responding to specific aim three, this paper provides lifetime prevalence estimates for different types of violence as perpetrated by different perpetrator categories. In particular, the paper focuses on the high rates of sexual violence experienced by FSWs. I argue that violence against SWs amounts to a hate crime which is fuelled by discriminatory attitudes and actions towards this population. At the heart of this are the aggressive masculinities which have developed within the township setting and which is underpinned by patriarchal norms which have resulted in sex work being criminalised.

Chapter Five of this thesis responds to specific aim 4, and includes paper two: Depression and post-traumatic stress amongst female sex workers in Soweto: prevalence and risk factors. A respondent driven sampling study. This study describes mental health concerns amongst FSWs, a highly-neglected topic, and argues that with the roll-out of sex work programmes in South Africa, there is the opportunity to provide mental health services to ensure that both physical and psychological health are addressed for SWs in South Africa.

Chapter Six is comprised of paper three, titled: Cross-sectional study of female sex workers in Soweto, South Africa: factors associated with HIV infection. This chapter responds to the first

specific aim through providing an HIV prevalence for FSWs in Soweto, while also developing a linear understanding of factors associated with being HIV infected.

Chapter Seven then addresses paper four, which is a response to specific aim 2, and which is titled: HIV-1 viral infectivity and drug resistance amongst female sex workers in Soweto, South Africa: A cross sectional study. The study describes HIV drug resistance (HIVDR) that was found within this population, and links this to treatment status, highlighting the critical gap in knowledge around the sexual acquisition of transmitted drug resistance (TDR) amongst treatment naïve FSWs.

Chapter Eight comprises paper five and described the complex interactions which result in sex workers vulnerability to HIV. In this we argue that HIV vulnerability comprises complex interactions between various mental health needs, exposure to violence, and childhood factors. This paper forms the basis for the discussion of findings from this PhD, drawing together the first four papers

Chapter Nine will then provide a comprehensive discussion of findings from this thesis, linking them to both the aims of the study, and to gaps in the knowledge. This chapter is guided by the discussion presented in Chapter eight.

Finally, Chapter Nine will conclude the thesis through suggesting a way forward. I argue that the findings of this thesis are supported by and add to existing evidence of the links between violence, mental health and HIV. Furthermore, that responses to HIV need to be multifocal, addressing violence, mental health and HIV.

2. CHAPTER TWO: BACKGROUND

2.1. HIV

2.1.1 THE SOUTH AFRICAN EPIDEMIC

South Africa has the largest HIV epidemic in the world with as many as 8.9 million people living with the disease [44]. Approximately 20% of all HIV-positive persons globally live in the country [45]. In South Africa, the epidemic is primarily heterosexual. A 2009 meta-analysis of findings about discordant couples shows that male-to-female transmission in low income countries was 0.30% per sex act, while female-to-male is 0.38% in the absence of commercial sex work. In the presence of commercial sex work, these increase substantively for female-to-male infectivity to 0.87% per sex act. However, the authors did highlight the possibility of methodological concerns amongst data from low-income countries [46]. In understanding evidence from South Africa, Pettifor et al [47] estimated the transmission probabilities using data from a cross-sectional national household survey of HIV for women ages 15-24 years. Their findings highlight the increased risk of male-to-female transmission, ranging from 0.74 to 1.00 per-partnership.

In 2008, infections peaked in South African amongst women aged 25-29 at 32.7%, with 2012 findings showing the peak now in ages 30-34. Gender desperation continued between 2008 and 2012, amongst younger age categories. Women aged 15-19 years-old were 2.7 times more likely to be HIV infected than males of the same age in 2008, while 17.4% of women aged 15-24 being HIV infected as compared with 5.1% of males in the same age category, in 2012 [48, 49]. Racial disparities are also clearly visible, with Black Africans being at substantially greater risk than any other racial grouping in the country [49]. Women in this age group accounted for 25% of new infections in sub-Saharan Africa in 2015[50]. In mid-2015, overall prevalence in South Africa amongst adults aged 15-49 years was 16.6% [44], rising to 18.9% by mid-2016 [51]. This suggests

that the country has continued to haemorrhage new HIV infections. In 2015 alone there were 529,670 reported new infections [52]. Within the general population, behavioural factors associated with HIV infection include inconsistent condom use [34, 53], early sexual debut, age disparity between partners and multiple concurrent partnerships. Sexually transmitted infections (STIs) also increase vulnerability to HIV [54-57].

South Africa's HIV landscape has a chequered political past, and is marred by an era of AIDS Denialism. The Mbeki presidency saw 330,000 AIDS related deaths occur between 2000-2005. Following the ousting of President Mbeki, unprecedented amounts of ART were distributed across the country in attempt to curb the epidemic [58]. In an attempt to curb the epidemic, treatment guidelines since then have varied from initiation at CD4 count <200 cells/ mm^3 [45], to the recently implemented strategy of offering treatment to all persons testing HIV positive (universal test and treat (UTT). Despite these changes and continued drives to increase access, 3.1 million people (less than half) were on ART by mid-2015 [59].

2.1.2 HIV AND SEX WORK

Globally, SWs bear a disproportionately high HIV burden [4], and much remains unclear about the key structural drivers of the HIV epidemic among FSWs[4, 60]. As shown in Table 1-1, recent studies suggest HIV prevalence of between 39.7% and 88.4% in this population [16, 18, 61].

Table 2-1: HIV prevalence amongst FSWs across three metropolitan cities in South Africa [1] and a major trucking route [2]

	Gauteng	Cape Town	Durban	N3 Route
HIV Prevalence	71.8%	39.7%	53.5%	88.4%

The 2013 South African Health Monitoring Survey (SAHMS) used an RDS methodology to recruit a total of 2,100 FSWs between Durban, Johannesburg and Cape Town, and found widely varying HIV prevalence between the three cities (Table 2-1). Of concern is their finding that more than two thirds of FSWs in Johannesburg were HIV positive [16]. They also found that knowledge of HIV status

was high amongst female sex workers (FSWs), yet uptake of treatment was poor (23.4 - 45.3%). In Johannesburg for example, 38% of FSWs knew their status but were treatment naive, of HIV positive FSWs, 21.6% were unaware of their HIV status, and only 12.2% of known positive FSWs were on ART [16].

In a second RDS study a sample of 128 FSWs were recruited along a major trucking route in South Africa, which showed that almost 90% of FSWs were HIV infected (Table 2-1) [18]. A 2012 meta-analysis revealed HIV prevalence of 11.8% (95% CI 11.6–12.0) among FSWs from 50 countries, with a pooled prevalence of 36.9% (95% CI 36.2–37.5) across sub-Saharan Africa [60], substantively lower than the 71.8% and 88.4% found in areas of South Africa.

A 2004 study conducted among antenatal women in Soweto (n= 3,982) demonstrated the relationship between transactional sex and HIV acquisition, with 21% of female patients reporting engaging in transactional sex, increasing the risk of HIV by 1.54 times (95% CI 1.07–2.21) when compared to women with no reported transactional sex relationships [26]. Together, these findings underscore the burden of HIV for FSWs in this region, and particularly those in South Africa where the rate of infection is substantially higher than in the general population [62].

Low levels of education, unemployment, gender inequality, violence, migration and poverty are all structural drivers of South Africa's heterosexual HIV epidemic [4, 62-64]. Together, these factors may also be important structural drivers of entry into the sex work profession [65-68]. A combination of the criminalisation of the profession [4] and exposure to high levels of violence exacerbates FSWs' vulnerability to HIV [69]. Age may also play an important role in SW vulnerability, with evidence that a third of FSWs in Johannesburg were aged 16–24 years (36.5%). Of these, 59.1% were HIV-positive [16]. While early sexual debut, and substance abuse are thought to be associated with entry into sex work [65-68], risky sexual behaviours have been cited frequently as one of the primary drivers of HIV prevalence among FSWs [63, 70-72]. These include multiple partners (both

clients and intimate partners) and result in increasing exposure to wider sexual networks [62] and substance abuse [9, 16]. Evidence has shown that as many as 81.5% of FSWs in Johannesburg, South Africa engage in binge drinking [16]. Alcohol has been associated with both HIV and unsafe sexual practices [69]. Various sexual practices, including limited or inconsistent condom use [73, 74] and unprotected anal sex [75], increase vulnerability. These factors increase vulnerability to STIs and HIV[72, 76-78].

Estimates of the number of new infections attributed to sex work have varied. In 2001, the South African Government claimed that 19.8% of new infections were attributed to the sector [79]. This was immediately rebuffed by the Sex Work Sector and more recent estimates suggesting that 6% of new infections are attributable to SWs directly[59], and that the variance between these two approximations are attributed to clients and other related Sex Work Sector parties. Research has found that men who purchase sex are more violence and more likely to be HIV positive than men who do not purchase sex. They also engage in more sexually risky behaviour such as not using condoms and multiple concurrent partnerships. Inappropriate client interactions with SWs through violence and sexually risky behaviours functions to increase SW vulnerability and drive the HIV epidemic. This is particularly important given that it is easier for women to become infected than men [47, 80-82].

In 2010, the African Sex Worker Alliance found that only 30% of SWs in South Africa were able to access healthcare services[83]. Between 2013-2016, 70 sex work programs were implemented through the Global Fund. From October 2013-March 2016, through the development of the Red Umbrella Programme, 34,638 SWs were HIV tested and 33,600 were reached with a basic package of HIV and violence prevention outreach and workshop services. Services included peer-education and outreach, monthly risk reduction workshops, HTS and condom distribution. The SAHMS suggested that 35.7% of FSW in Johannesburg had been reached by a SW peer educator, and 26.2%

had participated in an HIV-related talk. However, while 96% reported previously testing for HIV with almost half testing in the past year, 76% were treatment naive and almost 20% had not seen a medical professional in relation to their HIV diagnosis [16]. This suggests that programmatic reach was not optimal in 2013, FSWs were accessing basic HTS and a small portion using ART services through the then available mechanisms. However, given the HIV prevalence of this population it is clear that services to comprehensively curb the growing epidemic in this population remain in need of scale-up.

The launch of the South African National Sex Worker HIV Plan 2016-2020 aimed to remedy this through the provision of a comprehensive minimum core package of services which would be provided by various public-private partnerships. Minimum packages include peer education, access to ART, Pre-Exposure Prophylaxis (PrEP), and STI treatment, psychosocial and human rights services, social capital building and economic empowerment[59]. While the launch of a national plan is laudable, it should be noted that the plan took almost 7 years to develop, with extensive changes being made in editing out discussions surrounding the decriminalisation of sex work, for political palatability. In addition, implementation of the plan was complicated through donor agencies earmarking the same high prevalence settings resulting in service duplication and on the ground confusion for both implementing partners and SWs trying to access services. This has the potential to reduce the effectiveness and optimisation of service delivery. Thus, preventing outcomes, such as viral suppression or reduced new HIV incidence, from being achieved.

Achieving virologic suppression amongst sex work populations is challenging. One Canadian study of people who injected drugs (n=608), found that virologic control was not achieved during periods of selling sex [84]. In Zimbabwe, a cross sectional study of FSWs from 9 sites, found that 29.3% of HIV infected women were not virally suppressed [85]. While a Malawi-based study found that overall only 45% of FSWs were virally suppressed, but that amongst those who reported current

ART use, 86% were suppressed [86]. Furthermore, a cohort study of 218 FSWs in Kenya showed that higher viral load and lower early CD4 counts were predictors of death. A set point viral load increased the risk of death by 2.28 times per 1 $\log_{10}$ copies/ml increase[87]. Furthermore, of growing concern are the challenges to continued access to the HIV care continuum in many SW populations. A study of 268 HIV-positive FSWs in the Dominican Republic found an almost 25% drop-off between linkage to care and treatment initiation. They further showed that less than half (48%) were virally suppressed, with ART interruption and treatment defaulting being frequently self-reported. Their study showed the strong association between treatment interruptions and both internalised and experienced stigma, with a 3.24 and 1.09 risk, respectively [88]. Understanding viral load amongst FSWs in South Africa is of particular importance given the risk of HIV drug resistance (HIVDR).

2.2. ART DRUG RESISTANCE

Therapeutic success of first and second line ART regiments is limited by HIV drug resistance (HIVDR), making the prevention thereof a global priority[89]. The South African National Sex Worker HIV Plan 2016-2020[59] is geared to the provision of access to universal test and treat (UTT) through nurse initiated care in often clinically inexperienced partner organisations. Thus, there is an urgent need to understand aspects of HIV treatment provision which may require greater clinical oversight. There is a limited understanding of HIVDR amongst SWs in South Africa, which is problematic given the scale up of sex work programs. Should a significant proportion of the population develop HIVDR, the advances made in recent years, towards treatment and prevention of HIV, would potentially be lost [2, 90].

Three million people in South Africa were imitated onto ART in 2015 through the largest ART programme globally. As more people are placed on ART, the risk of HIVDR developing in the population increases, which impacts upon survival, quality of life, and prevention efforts [90, 91]. The longer individuals are exposed to ART, the greater their risk of developing resistance, placing

pressure on the public health system. A pressurised public health system is likely to experience events such as drug-stock outs, which will further the risk of developing HIVDR through treatment interruptions[92]. While regular viral load monitoring is standard of care in South Africa, it is undertaken infrequency and appropriate action in response to treatment failure is not always implemented. Thus HIVDR mutations may accumulate for patients who are continuing on failing regimens [90]. Drug resistant mutations can occur even amongst adherent patients who are virally suppressed through the sexual acquisition of transmitted drug resistance (TDR). Within the public health setting in South Africa, HIVDR testing is undertaken as a prerequisite to initiation of a third line regimen. Resistance testing is primarily available through centralised processes in government clinics and hospitals due to laboratory capacity and that non-specialist clinicians, such as nurses, have a limited understanding of the results [93]. The WHO suggested that between 2013-2014 in South Africa, 100% of clinics reported prescribing ART. However, only two thirds of patients were retained in care (67.8%) and just over one quarter (27.2%) timeously collected their ART pills. These are both early warning signs for the development of HIVDR [2, 90].

No increase in TDR was found during a meta-analysis of data from South Africa from between 2000-2010. With less than 5% TDR, this suggested that South Africa falls into the WHO classified 'low prevalence' country for TDR [94]. Subsequently, the WHO's 2012 drug resistance report highlighted the potential of increasing HIV drug resistance – both acquired drug resistance (ADR) which is a result of drug selection pressure, and TDR, when an individual with no exposure to ART is infected with virus that has existing drug-resistant mutations[2, 92]. More recent data suggests that HIVDR is increasing. HIV drug resistance was reported to increase between 2004-2014 in low-middle income countries, by the WHO. Furthermore, higher levels of TDR were documented amongst treatment naïve individuals. This was particularly so for non-nucleoside reverse transcriptase inhibitors (NNRTIs), which are used in many first-line ART regimens [92]. In South Africa, 2016 data from an NICD study showed that TDR was 14% [90, 95]. Modelling estimates

suggest that in the event of a UTT strategy with no other changes to diagnosis and retention rates, by 2032, 32% of the HIV positive population will be resistant to NNRTIs. Additionally, 30% of these individuals, or 9.6% of the total HIV positive population, will have a VL ≥500 copies/ml and thus be infectious [96]. Should the resistance mutations that develop be robust enough for sexual transmission, this will result in a continued growth of HIVDR in South Africa.

A 2013-2014 sample of pre-treatment patients from clinics across South Africa showed moderate levels of HIVDR (9%, 25/277) [97]. Amongst recently diagnosed (≤ 24 months) adults in KwaZulu Natal, 7.1% had HIVDR. The most common NNRTI mutation was K103N (27, 3.8%). NRTI resistant mutations were detected in 10 (1.4%) adults with 8 having only a single NRTI mutation [98]. A 24-week prospective study of treatment naïve HIV positive individuals in Uganda found that treatment interruptions >48 hours could result in drug resistance (13%) [99]. This is of particular importance amongst a sex work population, where police have been documented to illegally detain SWs for extended period without access to ART [14, 100] and thus increase their risk of developing ADR.

Regular surveillance for HIVDR in key affected groups such as SWs, is not routinely undertaken in South Africa, and available evidence globally is based upon very small samples from only a few locations. Amongst commercial sex work populations within Kenya, evidence from 2014 suggested a 22% prevalence of PI HIVDR mutations amongst treatment naïve SWs (24/109) [101]. A 2009 unpublished, cross sectional, laboratory-based, retrospective study from within the same cohort suggested that 8.3% of ARV treated FSWs within the Pumwani cohort had HIVDR (5/60)[102]. Studies of SWs in Argentina have found HIVDR in 12/62 (19%) [103], and 3/16 (18.8%) [104]. A 2005 study of FSWs and injecting drug users (n=11) along the US-Mexico border found two out of three ART naïve FSWs to have low-level resistance mutations. In addressing the dearth of data on

HIVDR amongst the sex work population, this study aims to describe the prevalence of HIVDR mutations amongst a sample of FSWs from Soweto, South Africa.

Overall, vulnerability to HIV is driven by a complex array of multi-level factors intersecting across the lives of SWs. These range from high level structural drivers of policy and legislative frameworks, to engagement in specific behaviours which may function to drive vulnerability at an individual level. It is important to gain an understanding of these factors as they impact upon SW vulnerability to HIV.

2.3 POST-COLONIAL GENDER INEQUALITY & SOUTH AFRICA'S CULTURE OF VIOLENCE

2.3.1 POST COLONIALISM & GENDER INEQUALITY

Gender inequality is pervasive across low-income countries, having an immense socio-cultural influence on health[105, 106]. While attempts have been made to address disparities, unequal access to employment, increasing numbers of female-headed households, and limited financial and economic security have meant that inequalities pervade. Thus, African women remain amongst the poorest and most disadvantaged in the world. In this context, women bear the burden of the HIV epidemic[107] and sex has become a currency for survival[11, 13, 60, 108].

This is likely to be compounded by South Africa's high levels of poverty and unemployment, and that poorer men have less resources at their disposal to help them constructively address social stressors; resulting in the deployment of negative coping strategies including alcohol dependence [109].

South Africa's socio-political history has fostered and normalised a culture of violence and inequality. The Government sponsored township violence, while state policies exposed millions of men and boys to humiliating, brutal and violent police and prison practices. Alongside this there was limited and discriminatory resource allocations, poor education systems and fragmented family

structures, with institutionalised racism leaving a legacy of low self-worth. This was underpinned by notions of male superiority through intrinsically patriarchal values. In combination, this enabled the creation of more violent masculinities predicated on toughness, superiority, and sexual entitlement [43]. In contradistinction are models of respectable femininity that encourage subservience [109-111]. Within this context, violence is used as mechanisms to enforce male dominance and control, while punishing female transgressions, [25, 109, 112, 113]. Such relationship inequities result in greater vulnerability to HIV through increased and prolonged exposure to men who engage in violent and sexually risky behaviours. In a context where social norms discriminate against SWs and position them as a devalued population, this is compounded, while sex purchasers are not as socially condemned.

Historically and institutionally, violence in South Africa became a culturally legitimate expression of dominant masculinities while also serving as an everyday method of coping with stressors, including poverty and unemployment. Violence is recreated in socially acceptable forms and legitimised across the lifetime, through actions such as punitively disciplining children, or during the resolution of disputes between a couple[114]. While men desire relationships with women they respect [115], SWs are not considered to be respectable women [13, 116]. Furthermore, the stigma associated with sex work, functions to increase the risk of IPV through the dehumanising the women who engage in the sale of sexual services [117]. In South Africa SWs describe being treated as if they were not human beings [118, 119]. Within a sex work context together with patriarchal norms and aggressive masculinities, violence is used to punish women who transgress traditional gender norms [109, 120], or who attempt to dictate the terms of a relationship and thus threaten male authority [25]. In addition, SWs are not respected as women because they are seen to be ‘paid for’ [13], thus reducing male pride centring on sexual conquests, and positioning the FSW as being ‘owned’ by the paying partner. Finally, unlike in intimate relationships, a sex exchange relationship offers no emotional protection from violence. These factors result in perceived transgressions being punished through

violence. SWs are not considered to have the right to give consent or to choose who she sells sex to, by clients, managers, police and healthcare officials alike [14].

2.3.2 STIGMA AND DISCRIMINATION

Stigma refers to infractions against norms that lack compliance with social accepted ways of being, or attributes that can be substantially discredited thereby discrediting the person possessing them [121-123]. Thus, SWs are ascribed a deviant or morally deficit characteristic, a flaw in their very being making them undesirable to society. Stigma can be internalised and felt leading to a sense of shame and blame of the self for engaging in sex work. It can also result in a disabling fear of experiencing discrimination thus resulting in the avoidance of health or policing services [122]. The enactment of stigma by others, constitutes acts of discrimination. The social norms surrounding sex work result in judgements of moral worth levelled against SWs. These centre on moral culpability relating to being a SW, or engaging in risky sexual behaviours [122]. This results in a spoilt identity for the individual concerned.

To understand these concerns, it is important to explore structural level influencers, such as power and domination. Parker and Aggleton [121] ague that stigma functions to create and recreate power imbalances in society. Thus, dividing the devalued individual from that of one positioned as socially superior, creating a socially iniquitous world [121]. To draw from the work of Foucault [124, 125], a cultural juxtaposition of differences enables the establishment and perpetuation of power in society. It allows one to define the normal against the abnormal or the morally deficit against the virtuous. Stigma can thus be positioned at the nexus of power, difference and culture, because, stigma should not be understood as individual attitudes or one off events, but rather as central to social order [121]. In thinking about stigma and sex work in this way, one can consider the role of violence and dominant masculinities as being in part driven by discrimination against SWs.

Limitations to their ability to excise power, and exposure to discrimination at all levels, from internalised shame and blame, to community and social-level discrimination may account for the poor uptake of available services by SWs. Accounts of nurses singling out suspected SWs and addressing them as “magosha” (prostitute or loose woman) are common [126]. Police brutality against women suspected of being SWs and the regularity thereof is a further manifestation of discrimination. Such discrimination and the resulting stigma and blame are pivotal to the success or failure of health initiatives [122]. This is compounding by community violence rooted in ideologies levelled against this population [5]. Through such negative and often brutal interactions SWs are rendered increasingly helpless to seek assistance. They are also exposed to discrimination for multiple deviations: HIV/AIDS, substance abuse, SW, uneducated, and a multitude of other. This creates multi-layered complexities for healthcare access for both SWs coming into the system for care and the service providers.

2.3.3 TYPES OF VIOLENCE

Emotional violence is the most commonly reported form of violence in Gauteng, with 44% of women experiencing it, and 65% of men admitting to perpetrating some form of emotional abuse (84). Physical violence which includes being subjected to physical force that can potentially cause harm, injury or death (85), is slightly less prevalent. A 2009 Gauteng study found that 33% of women had experienced physical violence with 74% experiencing some form of childhood physical abuse and 30% witnessed their mothers being abused (ref). Estimates range widely: one study suggested a lifetime prevalence of 25% with a 10% prevalence for the preceding year (ref); another suggested a lifetime prevalence of 40-50% (84). Data suggests that almost all women who have experienced physical violence have done so more than once (84). Violence can also be economic in nature, including limited access resources, controlled access to services and discriminatory laws impacting upon inheritance and property rights [127].

Sexual violence on the other hand includes "any sexual act, attempt to obtain a sexual act, unwanted sexual comments or advances, or acts to traffic, or otherwise directed, against a person's sexuality using coercion, by any person regardless of their relationship to the victim, in any setting, including but not limited to home and work" [128]. This includes unwanted sexual touching, rape and attempted rape.

Coercion is a crucial aspect of sexual violence and can involve physical force, emotional or psychological intimidation, threats or blackmail. A lack of consent could emanate from this or from being drugged, drunk, mentally incapable or asleep. While sexual violence can be perpetrated by a male to male or female to male, it is predominantly perpetrated by male against female. In South Africa, rape and childhood sexual abuse are the most common expressions of sexual violence (86-88). One in four women in Gauteng report having ever experiencing sexual violence, and as many report experiencing childhood sexual abuse. Almost 8% of women in the province reported a rape in the past year with 19% perpetrated by intimate partners (84). Yet only one in nine rapes are reported to the police. Jewkes and Abrahams [129] highlight that women are more likely to report incidents which fall within popular notions of rape, suggesting that the number of rapes occurring in South Africa is far higher than reported in the County's official statistics.

The legacy of gender inequality and non-reporting of rape is compounded by police "incentives" to reduce violent crime year on year. The incentivisation of violence reduction has the adverse effect of disincentivising the accurate recording of reported rapes. In addition, the improper basic definition of rape within the Sexual Offence's Act is a further complication. Until December 2007, rape was defined in common law as a male having unlawful sexual intercourse (penetration of female sexual organs by a male) with a female without her consent. However, the 2007 definition now specifies that 'sexual penetration' includes any act which causes penetration to any extent whatsoever by — (a) the genital organs of one person into or beyond the genital organs, anus, or mouth of another person; (b)

any other part of the body of one person, or any object, including any part of the body of an animal, into or beyond the genital organs or anus of another person; or (c) the genital organs of an animal, into or beyond the mouth of another person (33).

This more inclusive definition has seen an estimated 12% increase in the incidence of reported rape. While legal definitions may now be more inclusive, normative values result in many acts of sexual assault being considered as acceptable behaviour. For example, forced or coerced sex within a partnership or marriage is frequently seen as acceptable and not associated these with rape. Evidence suggests that 50% of people feel that a woman can be raped by her husband. Yet, only 29% of women feel that a wife can refuse her husband sex (84) and 1/3 of Gauteng residents believing that victim promiscuity is problematic (84).

2.3.3.1 GENDER BASED VIOLENCE (GBV)

Gender based violence is generally understood to incorporate emotional, physical and sexual violence by intimate partners and sexual violence by non-intimate partners, the sexual abuse of girls and sex trafficking of women[130]. The term is intended to recognise the subordinate position of women and girls in society[113]. The most recent data from Diepsloot, a township north of Johannesburg CBD, found that 38% of men reported perpetrating sexual assault, with 54% engaging in both physical and sexual violence in the preceding year[131]. In Gauteng, South Africa, more than half of women (51.3%) from the general population report some form of violence across their lifetime: 43.7% report emotional abuse, 33.1% physical violence and 23.5% sexual violence[132] This indicates the very high rates of GBV in South Africa.

Experiences of violence in childhood are a known risk factor for later victimisation[64, 133]. Research has conclusively shown the links between different forms of violence amongst the general population in South Africa [134]. It is important to understand exposure to violence and the multiple forms of violence they may be exposed to across their lifetime to ensure that programmes can be

effectively equipped to assist in this vulnerable population. Most studies on poly-victimisation have been carried out abroad, and limited evidence exists on the polyvictimization of FSWs in South Africa. However, a 2013 study which included a subset of Sowetan participants (n=2,663) found a three-times increase in GBV amongst women who had experienced childhood physical and/or sexual violence[133]. The exposure to GBV also impacts upon the cost of medical care for survivors, with one study showing a two and a half times increase in medical costs which persisted for a number of years post-incident[135]. The most recent South African data from Diepsloot, a township north of Johannesburg CBD, found that 38% of men reported perpetrating sexual assault. Additionally 54% reported having engaged in both physical and sexual violence in the past year [131].

Childhood Violence

Experiences of violence in childhood are a known risk factor for later revictimisation [64, 133]. The risk of intimate partner violence (IPV) increases through witnessing violence against a mother [37], and experiencing sexual violence in childhood [18]. A 2013 study found a three-fold increase in gender-based violence amongst women who had experienced childhood violence [36]. Through experiencing violence in childhood, dysfunctional behaviours are often normalised, and expectations around power are distorted. Sexual violence in childhood frequently reoccurs across the lifetime, and increases the risk of IPV [112].

Intimate Partner Violence (IPV)

Intimate partner violence is usually perpetrated by male partners who may be current or former partners, a spouse or boyfriend. Violence includes emotional/psychological, physical, sexual, or economic. Research from South Africa, shows that as many as one in eight women (13.8%) experiences IPV in the past year. Vetten et al, who draw from multiple sources (literature reviews and key informant interviews), highlights the high number of men who report engaging in partner rape (40%) [136]. Another study (n=1,395) found that 50.4% of Sowetan women (attending an antenatal

clinic), had experienced some form of physical or sexual violence by an intimate partner ever, and one third reported IPV in the preceding year. Intimate partner rape was also reported by 9.7% of women [64]. Women who experience partner violence, usually experience multiple forms of violence by the partner [137]. Evidence also suggests women who report engaging in transactional sex are that twice as likely to experience IPV [34]

Studies have also found that men who report engaging in IPV and rape are more likely to have multiple concurrent partners, drink heavily, purchase sex and not use condoms. Likewise, men who purchase sex also report engaging in violence [27, 138]. Together, these findings suggest that sex workers may, in their personal capacity, be exposed to violence perpetrated by their intimate partners. In combination with gender inequalities emanating from hegemonic masculinities, we believe that this results in a multi-perpetrator vulnerability to violence against FSWs. Together, findings from these studies suggest that exposure to rape amongst SWs may be higher than within the general population[139].

2.3.4 SEX WORK & VIOLENCE

Sex workers epitomise South Africa's dual HIV and violence epidemics[16, 69, 71]. Despite a constitution lauded internationally for being grounded in human-rights, the country has a highly patriarchal society with pervasive violence against women[111]. Little is known about the patterns and prevalence of victimisation and poly-victimisation amongst SWs in South Africa. Yet violence is a normalised part of SW [14]. Recent evidence shows high levels of past year violence exposure for FSWs in Cape Town, and Johannesburg: 47.3% physical and 16.2% sexual in Cape Town, and 50.9% physical and 21.9% sexual in Johannesburg [16].

In understanding violence against SWs, it can be useful to consider such violence in relation to patriarchal norms, aggressive masculinities, discrimination against SWs, as shown in Figure 2-1, below.

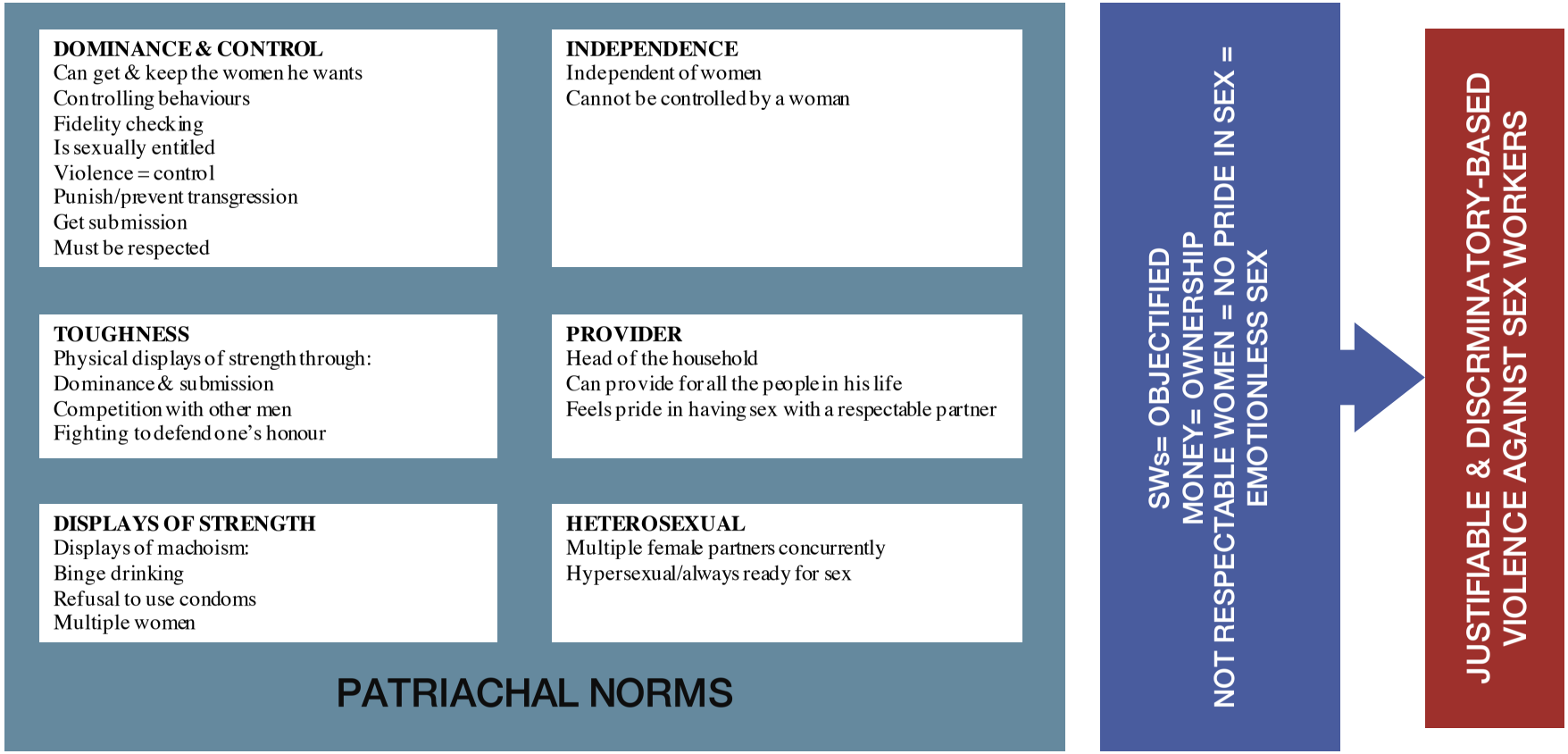

Figure 2-1 A model of vulnerability to violence for SWs, showing how patriarchal norms underpin aggressive masculinities. This is driven by dynamics surrounding sex work, resulting in a justifiable form of violence against SWs.

Given the launch of the South African National Sex Worker HIV Plan 2016-2020[59] and the scale up of sex work programs across the country, understanding the trauma experienced by this neglected and marginalised population is important to developing effective interventions. Violence has been found both locally and abroad to be associated with inconsistent condom usage, STI and HIV acquisition, undermining economic capital and having a widespread social impact[137, 140-143]. The resulting mental health impact, including post-traumatic stress disorder (PTSD), and depression, often undermine individuals' effective functioning[137, 144]. This may result in substance abuse or a lack of adherence to chronic medications such as antiretroviral therapy[1].

Yet, there is inadequate information on polyvictimization by these perpetrator groups, and the overlap with other forms of violence, including IPV. Modelling estimates have suggested that through addressing violence amongst SWs, 25% of HIV infections amongst this population could be averted[145]. As such the vulnerability of SWs to violence is complex and requires more knowledge in developing an understanding of the patterns of violence amongst FSWs, particularly in under researched areas. Little is known about the vulnerability of FSWs to violence in Soweto, a large township on the outskirts of Johannesburg where sex work takes place[10, 146].

2.3.4.1CHILDHOOD VIOLENCE

Sex workers experience multiple forms of violence across their lifetime. Globally, evidence has also shown levels of childhood sexual abuse amongst FSWs to range from 32.4%- 42.0%, and that sexual abuse in childhood is higher amongst SWs than other women [38, 39]. Experiences of violence in childhood, normalise dysfunctional behaviours, and distort expectations of power. The trauma also affects the physiology of the brain, impacting upon emotional stability and relationship formation in adulthood, promoting vulnerability to violence [18].

2.3.4.2 INTIMATE PARTNER VIOLENCE

Violence exposure for FSWs is typically researched in terms of clients and police as perpetrators. However, this is not always the case. A study of substance abusing SWs in South Africa showed that 19% of had been raped by an intimate partner in the preceding year, and 63% had been beaten by their intimate partner [139]. A Kenyan-based study found that 79% of FSW had experienced some form of IPV in the preceding 30 days. No IPV within the past 30 days was associated with more consistent condom use [147]. Internationally,

Within the general population, violence by intimate partners is significantly associated with an increased risk of both depression and PTSD. A qualitative study (n=182) found a higher incidence and severity of depression, suicide ideations and PTSD amongst women who had experienced IPV than those who had not, as reported during structured interviews [148]. Yet there is little known about SW, IPV and mental health.

2.3.4.3 CLIENT VIOLENCE

The purchasing of sex either formally or informally, is common in South Africa. Jewkes et al [149] interviewed 1,645 sexually active men aged 18-49 years in a nationally representative, and found that 18% had purchased sex from a sex worker while 66% engaged in transactional relationships. A second study from the same sample [150] shows that men who had recently purchase sex were more conservative and violent. Three quarters of the men who had purchased sex scored significantly higher on misogyny, psychopathy, engagement in violence towards women, and they reported engaging in (other) criminal activities. Findings from a cluster design study including 1,738 areas across the Eastern Cape and KwaZulu Natal show that men who report rape perpetration also report engaging in other high risk behaviours such as transactional relationships, multiple concurrent partners, substance abuse and inconsistent condom use [151].

In addition, evidence from a cross sectional study (n=1229) shows that younger men who engage in IPV are more likely to be HIV positive [152]. This highlights the vulnerability of women selling sex to violent and often HIV positive men. A sample of 202 men in the United States of America was matched by age, ethnicity and level of education, for sex buyers and non-sex buyers. Findings suggested that perpetration of violence by sex buyers was supported through a lack of emotional connection, that they had a low level of empathy for sex workers, and that they sought emotional disconnected sex [120].

Such findings suggest that SWs are particularly vulnerable to violence perpetrated by clients in the form of emotional, physical and sexual violence. This is confirmed by various studies on SW vulnerability to client violence. A 2008 study of sex workers in Cape Town, South Africa, showed that 37% of street-based SWs and 20% of brothel-based SWs reported ever experiencing client violence. In the same study, 70% of SWs said that they feared clients the most out of all perpetrator types. [14]. Similarly, a 2011 study qualitatively interviewed 107 FSWs across four African cities, including Johannesburg and found that sexual violence perpetrated by clients was common [119]. A study in KwaZulu Natal that interviewed truck drivers found that 37% always stopped to buy sex on route. While more than half were HIV infected (56%) and HIV status was known to almost all, 29% refused condom use with SWs, and 13% refused condom use with their wives [21]. Evidence has shown the association between men who purchase sex and engaging in IPV, rape, multiple concurrent partners, binge drink, and refusal to use condoms [27, 138].[120]. Dunkle et al [138] interviewed 1275 men aged 15-26 years from across the Eastern Cape, South Africa. There findings showed that 31.8% of men reported physical or sexual violence perpetration against a female partner. Increased perpetration was positively correlated with number of sex partners (for both the past year and lifetime), engagement in transactional sex or casual sex relationships, non-partner rape and substance abuse. A second study from the same cohort, looked at transactional sex and GBV [22].

Their findings show that 17.7% of men reported engaging in transactional sex relationships. There was a 5.6 times greater risk of engagement in physical or sexual IPV for men who engaged in transactional sex, and a 1.6 increased risk for those engaging in non-partner rape.

2.3.4.4 POLICE VIOLENCE

Research also shows SW vulnerability to police harassment and abuse, emotionally, physically, sexually and economically. One qualitative found that amongst SWs, including those in Johannesburg, sexual violence perpetrated by police was common[119]. In 2008, findings were published from a study of SWs in Cape Town which highlighted the harassment of SWs by police, 12% reported ever being raped and 47% threatened with violence, while 28% had been asked for sex in return for being released from police custody [14]. Police violence and harassment of SWs is currently being comprehensively documented by various human-right and legal organisations, including the SWEAT and Sonke Gender Justice. Their preliminary report draws from which draws from direct witness statements using qualitative interviews (n=63), and a survey instrument (n=57) [100]. They document serious criminal offences perpetrated by police against SWs, including "torture, assault occasioning grievous bodily harm, rape and sexual assault, unlawful arrest, unlawful detention, and corruption on a systematic scale at specific locations" (p10). They also note that police neglect of duties in certain areas. The following is an excerpt from a witness who was dumped in Soweto following an unlawful arrest:

> "*The police beat me around the head very hard. They were punching me and I was bleeding. They hit me so hard a tooth flew out of my mouth. I started to bleed from both my ears as well as my mouth ... Since the police beat me up I cannot hear properly. I am worried that I will be deaf from the damage they did me. My mouth is still swollen with a big lump on my jaw on the right-hand side, the same place where the tooth flew out of my mouth when the police hit me so hard. I am still in a lot of pain*" (35-year-old FSW, p53)

A second statements highlights the culture of rape, including FSWs, by police. This woman was picked up in a tavern having previously been raped by the police officer who was taking her fingerprints after arresting her.

> "*I was too frightened to say no to the police officer. He had a gun and I thought he would hurt me. The police officer told me I was his girlfriend and every weekend he would come and find me and take me to the police barracks to have sex with me. He used to lock me in his room whilst he was on duty, and then come back and have sex with me. The barracks were full of police officers, I thought they would hurt me if I yelled or tried to get help. I could hear other ladies screaming from other rooms in the police barracks*" (45-year-old FSW).

Fear of and unsympathetic treatment by the police ensure that few abuses get reported [11, 153]. Where incidents of rape are reported, sex workers are often left feeling further traumatised and humiliated by degrading and humiliating police treatment. Such police action has led to discomfort in reporting any form of violence to the police [11].

Exposure to such violence results in not only humiliation and shame, but also in emotional scarring, psychological stress, depression and low self-esteem [11] [69]. It also increases the possibility of serious health complications [11], such as unwanted pregnancies, genital injury, STIs, HIV and emotional trauma. Violence against sex workers is often driven by the criminalisation of the profession. This drives discriminatory agendas within the police force, which include encouragement of police harassment by authority bodies such as the National Prosecuting Authority [154]. As such, there are few reliable sources of information on the prevalence of violence against SWs, and independent research is required.

Criminalisation of Sex Work

The criminalisation of sex work has created imbalances in access to health and legal services, which render SWs increasingly vulnerable to violence, exploitation and health concerns[4, 5, 60, 69, 70]. This is evident in the inequalities seen within the South African HIV epidemic where: sex workers are at substantially greater risk of contracting HIV than the general population; their access to healthcare has been curtailed through fear of being identified as engaging in a criminal activity; and service provision is often conditional on implementing organisations agreeing not to advocate for the legalisation of the profession. This situation has, until very recently, been further compounded by a lack of government impetus to assist this population group [155]. Research has shown that criminalisation underpins much of the health concerns facing SWs today. Studies have shown the prejudicial attitudes of healthcare workers result in limited access to services, driving SWs away from health care [5, 126, 155]. Additionally, exposure to violence is higher amongst SWs than the general population, including exposure to sexual violence [16]. Studies have documented across Africa, and including South Africa the vulnerability of SWs to arrest in relation to the sale of sexual services. This frequently results in rape by police, financial extortion, assault, and prevented access to ART, all of which function to further SW vulnerability to HIV and an inability to effectively manage this chronic illness [5, 14, 118, 119, 126, 156-158]. In these ways, criminalisation leads to greater economic insecurity due to police or client bribes being paid to secure freedom, and thus greater risk taking to ensure continued economic viability by SWs who are frequently financially responsible for providing for extended families. This situation is compounded by the unsafe working conditions which SWs are exposed to through an unregulated industry. As such they often work in spaces which are inherently dangerous, such as dark alleys, abandoned buildings or parking lots, drinking establishments or hotels [155]. Research shows that where the sex work industry is regulated, there are far better health outcomes and there is a reduction in the regular abuse of women [159].

Sex workers have historically been blamed for the continued spread of HIV, with little thought being given to the role of their economic marginalisation and vulnerability to, amongst other human rights violations, violence as driving factors of HIV. Criminalisation drives issues such as discrimination against SWs. The law which was initially intended to reduce the prevalence of sex work, now serves to render SWs increasingly vulnerable to violence and exploitation. It forces them to become a hidden population, rendering them more vulnerable to health issues, while hindering their access of health and legal services. This perpetuates the stigma associated with their work, at the same time increasing client dominance and power over them [5, 13, 155, 159, 160]. Such attitudes and actions are further maintained through South Africa's patriarchal society, which supports the often-violent subjugation of women in general, and sex workers in particular [161].

While South Africa's Constitution (Republic of South Africa, 1996) is based on principles of human rights, it is clear from the available literature that sex workers are discriminated against on multiple levels. South Africa's Constitution [162] is lauded for its human rights principles. Yet, it is clear from the available literature that SWs are discriminated against on multiple levels. In 2001, the then National Minister of Health, Manto Tshabalala-Msimang [70] was quoted as stating that "because of stereotypes about their profession, they [SWs] are poorly treated by mainstream service providers and other institutions". Again, in 2016 the South African National AIDS Council stated their support for the decriminalisation of sex work, while Deputy President Cyril Ramapoza committed to a review of legislative frameworks criminalising the profession. Yet the recent Law Reform Commission's review of the policy [163] recommends no change in law while the draft National Strategic Plan 2016-2020 steers clear of this debate [164]. Despite the principled stances of a few, very little has been done. This result is state complacency surrounding violence and discrimination against SWs.

Sex workers face violence often in the form of stigma associated with prostitution, HIV, gender inequality, racial issues, drug use or other factors. Such hostilities towards SWs are grounded in moral ideologies surrounding gender normative behaviours which SWs frequently transgress, and the persons enacting violence are infrequently held accountable. Men who purchase sex, are also not as socially condemned for their role in either the buying of sex, or their perpetration of violence against SWs. Violence against SWs is frequently disregarded by health and policing officials. A SWs right to give consent or to choose who she sells sex to, is regularly overlooked by clients, managers, police and healthcare officials alike[14]. Evidence suggests that SWs who attempt to report sexual violence to policing officials are frequently re-victimised by the police[14]. Similar behaviours are reported about health officials[119].

Thus, the evidence strongly suggests that punitive laws and policies function to increase SWs risk of both acquiring and onward transmission of HIV [155]. These laws have been shown to facilitate enactments of stigma through the institutionalisation and thus validation of discrimination [11].

2.4. EDUCATION & EMPLOYMENT

As with most infectious diseases, an inverse correlation exists between education and HIV. There is no definitive conclusion as to how education protects against HIV. Some suggest that it is the link between education and HIV knowledge which vaccinates a person against the disease. Other studies suggest that education empowers young women to internalise HIV information and thus make more informed and better decisions[165]. Within South Africa, not only is there a blanket silence surrounding discussions on sexuality and HIV in many African families[166], but the overall level of education within the country is poor.

During the apartheid era, education was used as a means to ensure the subjugation of all non-white citizens[167]. This substandard education has left a legacy of social, economic, and behavioural disparity within the country which persist to this day[168]. Since its democracy in 1994, the Grade

12 pass rate has on paper increased, from 53.4% in 1995, to a high of 78.2% in 2013, [169]and 72.5% in 2016 [170]. This only equated to 56% of learners completing a grade 12 by 2015 [170]. There are concerns that the pass rate while indicative of potential opportunities open to the youth, holds little substance. The National Department of Education has implemented various strategies in an attempt to improve South Africa's basic education system. This has included pushing failed learners through to the next year of schooling through the 'progressed learner policy'. In 2015, more than 65, 000 learners who had not met the basic requirements for the grade, had been pushed into the next year. This results in a double-bind of poorly equipped leaners being further disadvantaged as they compete against their academically competent class mates. Furthermore, the overall standard of education is lowering to accommodate failing learners. Unsurprisingly, the dropout rate for learners between grades 10-12 was 30% in 2015 [171], while adult literacy rose only 14% between 1997 and 2014[172]. Together, these factors have resulted in a growing educational crisis, with a burgeoning uneducated population. In 2016, the Minister of Basic Education admitted that schools in the country were in a crisis.

Education is a key aspect of unemployment[173], which is officially 26.5%. However, only 43.5% of the working age population in the country are currently employed. Youth unemployment is higher at 54.2%[174]. This exacerbates levels of poverty in the country. A 2008 study showed the correlation between unemployment and educational outcomes, with 30.4% of persons who had not completed their basic education being unemployed in 2005[175].

Reports on education levels amongst FSWs vary widely, but have generally been found to be poor [59]. A 2011 report by the African Sex Worker Alliance found that 93% and 83% of SWs in Johannesburg and Limpopo, respectively, had completed their grade 12 [119]. However, the SAHMS suggested much lower levels of education between Cape Town, Durban and Johannesburg, at only 38%, 42.3% and 37.5% having completed their high school or undertaken some tertiary level

training, respectively[16]. Failure to complete schooling and no alternate employment avenues has been cited as a reason for entry into the sex work profession[119]. This is confirmed by a Cape Town-based study which found that most people entering sex work did so to meet financial needs [14], likely related to economic inequalities in South Africa and the high levels of poverty. It has also been shown that they remain in the industry due to the higher earning potential when compared with employment such as domestic work or waitressing [14]. However, poverty may also function to maintain individuals who have limited alternative economic survival skills, in the profession.

2.5. MIGRANCY

South Africa has a long history of both internal and external migrant labour[176-179]. With the advent of gold and diamonds in the early 1900s, the mainstay of South Africa's socio-economic and political development centred on the subjugation of cheap, black, male labour. This influx of male labour to mining epicentres such as Johannesburg, functioned as a major determinant of disease patterns across the country, where STIs can still be tracked along traditional migratory paths[177].

Today, economic migrants come from all corners of South Africa, converging in Johannesburg as a city with the potential to improve their lives [11, 13, 71]. This trend in movement has resulted in a number of vulnerability factors, including disruption to familial relationships and the disempowerment of women[177, 179]. Intertwined with the present day lack of education [11, 13], the high rate of unemployment, and an ineffective healthcare system, migrancy increases the vulnerability of disadvantaged people to disease. In addition to these internal migrants, political turmoil in Africa has led to an increase in cross-border migrations. Many international migrants settle in the greater Johannesburg area. There they are vulnerable to xenophobic attacks by local residents, linguistic difficulties, a lack of social capital, as well as food and housing insecurity. All of which have been identified as creating particularly harsh barriers to accessing services such as healthcare [13, 180, 181].

For many migrant women, the move represents an attempt to seek autonomy through independently earning money and a departure from the traditional roles into which they have been born. For low-income and marginalised populations, sex work may become the economic cornerstone of their survival, and therefore the healthcare issues they are most vulnerable to are sexual and reproductive in nature [11, 13]. Evidence shows the strong association between migrancy and HIV, with male migrants having a 2.4 times greater chance of being HIV infected [182] and female migrants being 1.61 times more likely to be positive[183] than their non-migrant counterparts. While long-term migration from non-endemic regions is associated with increased consistent condom usage and lower HIV prevalence, short-term or inter-area mobility is associated with increased HIV vulnerability [4].

International evidence clearly highlights linkages between migration and sex work, but there is limited information from South Africa[184]. The 2013 SAHMS suggested that as many as 31.5% of FSWs in Johannesburg were migrants. Of these, 86.6% are HIV positive, as compared with 66% of South African FSWs in the same study [16]. While, a 2010 study found that 85.3% of FSWs interviewed in 3 South African cities, including Johannesburg, were migrants. This comprised of 39% internal and 46.3% external migrants. Their study found that while external migrants had high levels of education, condoms were used less frequently and access to health services was poor[184].

2.6. MENTAL HEALTH CONCERNS

Mental illness is a global phenomenon. Evidence suggests that about 14% of the global burden can be attributable to neuropsychiatric disorders [185]. In sub-Saharan Africa, in 2001 as much as 10% of the disease burden could be attributed to neuropsychiatric disorders [186]. Mental health is an important mechanism in addressing the unabated growth of HIV. However, the connectedness between mental health and other health conditions is often inadequately appreciated [185] and it is likely to impact upon vulnerability both to and from HIV.

Globally, exposure to violence and HIV are associated with poor mental health outcomes [187-190]. Childhood exposure to violence has also been shown to impact negatively upon adult mental health [191]. Experiences of trauma can cause physiological changes in the brain, potentially impacting upon emotional stability and relationship formation during adulthood, which can further vulnerability to violence [112]. Despite evidence to suggest that SWs have high exposure to trauma [16, 160, 192, 193] and that trauma impacts adherence to ART [194], there has been limited research on the mental health needs of SWs. This is a critical gap in the literature given that South Africa is in the process of scaling up sex work programs, and a core component of this is the need for improved adherence to both ART and PrEP [59]. It is thus vital that we begin to understand mental health concerns such as depression and post-traumatic stress disorder amongst this population, and in the fight against HIV. Such mental health concerns are frequently comorbid [195], complicating treatment options in limited resource settings.

HIV prevalence is four times higher amongst individuals who have mental health concerns [196]. Both biomedical and behavioural components are frequently included in HIV prevention and treatment interventions. Beyond the inclusion of counselling or HIV support groups, mental health is infrequently considered to be important in the HIV armoury. Despite this, evidence shows that mental health concerns such as depression and substance abuse impact negatively upon ART adherence [197, 198]. More than a two-fold increased risk of non-adherence resulting from depression and anxiety was found in a nationally representative sample (n=1910). The same study also showed a 14-fold increase in missing daily ART for persons with any psychiatric disorder [198].

Mental health in SWs has infrequently been studied. One study based in Switzerland found that 50.3% of SWs (n=194), suffered from some form of mental health disorder. The same study found that being a migrant SW increased the risk of mental health concerns by almost nine times, while violence increased the risk by three times [199]. A second study based in the United States (n=24)

found an association between anxiety, depression and self-esteem amongst women who engaged in transactional sex [200]. More recently and within South Africa, a 2017 study of SWs attending a support group in KwaZulu Natal (n=155), found that experiences of stigma and childhood abuse were bivariably associated with depression. They also found that 78.4% of their sample suffered from depression and anxiety, while 80% engaged in binge drinking [201]. Recent findings from Soweto highlight the burgeoning violence epidemic, with more than three quarters of FSWs experiencing some form of physical or sexual violence across their lifetime [202]. The mental health needs of SWs in South Africa are poorly documented. It is vital that a comprehensive understanding be developed around all aspects of SW vulnerability. This study aims to understand the prevalence of both depression and PTSD as well as associated factors amongst FSWs in Soweto, South Africa.

2.6.1 DEPRESSION

In South Africa, data from 2002-2004 found that lifetime prevalence of major depression was 9.7%, while past year prevalence was 4.9% [203]. Major depression has been shown to impact the course of HIV [204]. Research has shown the significant association between depression and alcohol abuse [191, 195, 205]. It has been estimated that by 2020, both HIV and mental illnesses (resulting in suicide) will be amongst the top 10 causes of mortality in developing countries. Research has shown the influence which HIV has on the nervous system culminating in a plethora of neuropsychiatric disorders, including both mood and anxiety disorders [206]. ART adherence was 55% lower amongst depressed populations than not depressed [194]. Level of depression is also associated with lower levels of education and being female [203]. Furthermore, there are the high rates of depression amongst female rape survivors (28% and 34% respectively) [207-209]

2.6.2 POST TRAUMATIC STRESS DISORDER (PTSD)

Both globally and locally, the interconnectedness between HIV and mental health has been shown through examples such as increased risk-taking behaviours including inconsistent condom use by

young women with low self-esteem [210]. Research has shown the significant association between PTSD and alcohol abuse [191, 195, 205]. While past year sexual assault is associated with PTSD [195]. Research has shown that approximately 16.5% of South Africans suffer from PTSD [180]. Furthermore, there are the high rates of PTSD amongst female rape survivors (28% and 34% respectively) [207-209]. A 2008 study in South Africa (n=4351) highlighted the strong association between PTSD and violence. More than one third of females (34.3%) reported violence exposure resulting in a 0.9-3.2 times greater risk of PTSD when compared to non-violence exposed women [209].

2.6.3 SELF-ESTEEM

Evidence has shown the relationship between low self-esteem and increased sexual risk behaviours such as poor condom use and increased binge drinking [200]. Furthermore, there are established links between low self-esteem and decreased health seeking behaviours. A 2003 review of available literature showed the impact of self-esteem on unsafe sexual behaviour, the resulting impact upon HIV risk, and the negative consequences for health seeking behaviours [211]. The link between self-esteem and self-efficacy, or the belief in one's ability to undertake a task such as negotiating condom use, is an important component of safer sex practices [212] and engagement in the healthcare setting [213]. Thus programs fostering these issues are likely to yield less risky sexual behaviour. As with with other mental health issues and despite the extremely high exposure to trauma found in this population, there is limited knowledge on self-esteem amongst SWs. One small study based in the United States (n=24) found an association between anxiety, depression and self-esteem amongst women who engaged in transactional sex [200]. Other evidence has suggested the likely impact of criminalization upon the self-esteem of commercial sex workers [69]. Understanding the role of self-esteem in SW HIV vulnerability may provide us with an important component to include in the scale up of sex work programs in South Africa.

2.6.4 SUBSTANCE USE OR ABUSE

South Africa has well documented substance abuse concerns. Alcohol accounted for 7.1% of all deaths in 2000 [214] and in the same year the per capita consumption was higher than in most other countries at 20 litres per year per adult [215]. Research has shown that 1:4 and 1:10 males and females (respectively) experience drinking problems [216]. Although more than R50 million is spent on beer annually in Soweto, there has been a documented increase in the use of alcoholic fruit beverages and spirits [215], suggesting that substantially higher volumes of alcohol are consumed within the township. A WHO rapid assessment highlighted the strong association between alcohol and sexual risk. In 2005, the need for inclusive HIV intervention strategies which address alcohol abuse was suggested [217]. Research has shown that while South Africa has high rates of substance abuse disorders, access to treatment remains inequitable due to limited service availability for the poor [218]. Despite this, the South Africa National Sex Worker HIV Plan 2016-2020 makes provision for SWs to be referred for substance abuse disorder [59].

The presence of alcohol is an aggravating factor for both violence and HIV infection, with HIV positive women being 1 to 3 times more likely to report violence in the context of an alcohol or drug problem [190]. The availability of drugs and alcohol within sex work venues increases the likelihood of SWs experiencing violence[141]. Drugs have also been noted as common practice amongst SWs either through needing to support a habit, or as a coping strategy in response to the stressors from the sale of sexual services. However, drug and or alcohol use increases the risk of unprotected sex, exposure to violence and vulnerability to health concerns [139, 219]. Evidence highlights alcohol and dagga as the most commonly used substances, with heroin and cocaine being popular alternatives. A small Pretoria based study suggested that 18% and 24% of sex work had used alcohol every day or at least twice per week respectively with daily cocaine use standing at 72%. Forty-four percent of SWs reported using drugs with their clients[139]. Taken together, the evidence suggests that there could possibly be very poor uptake of consistent condom usage amongst.

2.7. SEXUAL RISKY BEHAVIOURS

Evidence suggests that risky sexual behaviours such as douching, inconsistent condom usage with both intimate partners and clients, and the high number of sexual partners all act to increase the health risks of SWs. Within a context of poor access to healthcare, this compounds the high HIV prevalence found amongst this population [64]. Dry sex or douching practices, which include inserting various drying or astringent agents into the vagina, can lead to lesions, ulceration and altered pH-levels [78]. While condom use has been documented amongst SW populations, other sexual practices including the practice of hiding menstrual blood while continuing to sell sex have infrequently been documented amongst these populations. Such practices may have implications for HIV prevention efforts and further research is required to understand their use by SWs. Unprotected anal sex also increases HIV vulnerability by between 1.4 [82] and 5.1 [80] times, with as many as 40% of FSWs along a South African trucking route reporting engaging in anal sex [75].

2.7.1 CONDOM USE

While HIV is reportedly the leading reason for condom usage. Evidence suggests that as many as 67% of men have had at least one problem with fitting a condom. Almost half of these suggested that condoms were too small, 53% reported a condom breakage and 41% condom slippage during sex. Furthermore, dissatisfaction with condoms is high in South Africa, with more than one third of men disliking the feeling [220]. Such concerns are likely to impact the uptake and consistent use of condoms when sex is being purchased, and may result in a high rate of condom breakage, slippage and client demands for sex without a condom. Yet there is minimal evidence available to corroborate inconsistent condom use amongst SWs. Bekker et al[140] suggest that as many as 70% of new sex work infections have already been averted through condom promotion and distribution programmes in South Africa. Recent data from the SAHMS suggests that the uptake of condoms at last sex with clients, was high (84.6%). Yet in the same study, HIV prevalence was 71.3%, suggesting that condom use at last sex may not be an accurate reflection of condom consistency over time. More

comprehensive screening is likely required to measure consistency and correctness of condom use [221].

Consistency of use is impacted by a number of factors. For example, in South Africa police have been documented to use condoms as evidence of sex work in illegal arrests, resulting in fear of using condoms by SWs. Condoms confiscation by police has been documented organisations working with SWs in South Africa [154, 193]. Such evidence highlights that challenges which SWs have in consistently having condom available to use. Research also suggests that condom usage is lower between SWs and their intimate partners [16]. Studies have shown that community mobilisation efforts combined with SW-led outreach, advocacy and intergovernmental partnerships are all critical in increasing the uptake and consistent usage of condoms [222, 223].

2.7.2 MULTIPLE CONCURRENT PARTNERSHIPS

Evidence shows that there is a significant increase in the risk of HIV with increases in the number of lifetime partners [47]. Modeling estimates have shown that multiple concurrent partnerships are important in advancing the epidemic through speed of transmission, size of the epidemic and persistence in a given population group [224]. The heterosexual risk of transmission in the general population from male to female per sex act was estimated at 0.0005–0.0026 in 2010 [225]. A recent study of FSWs in China which drew from longitudinal data of both SWs and their clients, suggested that the risk per sex act was 0.0023 [95% *CI* 0.0014-0.0032] [226]. This suggests a possible 4.6 times increased risk of HIV acquisition per sex act. Given the nature of sex work, it is unsurprising that SWs are heavily affected by the multiple partnerships they both engage in and are exposed to, which are likely key drivers in the populations HIV prevalence.

2.7.3 DRY SEX PRACTICES

A study of 513 South African men and women aged 16-35 years, showed that dry sex was practiced by 46% of women and 60% of men [227]. The findings showed the increased prevalence of dry sex

amongst younger persons and those with lower education. Furthermore, the increased risk of STIs for those practicing dry sex. Further studies have intimated the vulnerability of FSWs to practices such as dry sex, due to the power dynamics in their relationships with clients [228]. However, there is limited evidence to describe the prevalence of dry sex practices amongst FSWs in South Africa.

2.8. CONCLUSION

The overall literature presented above outlines a bleak picture of sex work in South Africa. Disproportionately high levels of HIV plague this population who are concomitantly exposed to disparate levels of violence when compared to the general population. Limited information is available on their mental health, despite calls for strategies to improve adherence to medication - which is fundamentally linked to mental health. While there is a plethora of data on SWs in Hillbrow, Johannesburg, and Cape Town, SW until recently was not considered to take place within township settings such as Soweto. This limitation in context specific knowledge, including basic information on demographic characteristics such as age and education levels are critical factors in effectively tailoring interventions. Little is known about the intersections between HIV and a multitude of other factors such as mental health, childhood exposure to violence, lifetime exposure to different forms of violence or migrancy for FSWs. It is also not yet understood how these factors function in often complex ways to drive multilevel vulnerability to HIV. Overall there is limited information globally on HIV drug resistance, let alone amongst SWs who have a substantially elevated HIV risk profile. This information is vital for the scale up for SW projects in South Africa, and may have important implications for the clinical management of SW programs. Given the scale of South Africa's HIV epidemic, it is vital that knowledge be generated which enables a greater understanding of key populations and how best to begin mitigating their risk and vulnerability to HIV alongside associated driving factors. It is with this in mind, that a methodology to understand factors associated with HIV infection was developed. In doing so, the methodology needed to take

cognisance of the populations needs and challenges to accessing FSWs in Soweto. As described in detail below, our methodology used an innovative approach to both recruitment and data collection through proactively engaging the sex work community in all aspects of the research design.

3. CHAPTER THREE: PROGRAMME DEVELOPMENT & STUDY METHODOLOGY

3.1. OVERVIEW

This study employed a prospective, quantitative survey to understand HIV acquisition and disease progression amongst Soweto SWs. Through using respondent driven sampling (RDS) in a cross-sectional design, the population prevalence results from this study were generalisable to the Soweto sex work population. We also feel that our findings on mental health, violence exposure and HIVDR are highly likely to be applicable to all sex work populations in South Africa. Given that minimal published evidence-base exists on Soweto SWs, this study offers a unique insight into the factors associated with HIV in the township's sex work population.

3.2. THEORETICAL FRAMEWORK

This cross-sectional study draws from Bronfenbrenner's ecological systems framework [229]. Bronfenbrenner believed that an individual should be understood within the context of their environment, which could be divided into five layers. An individual is exposed to continually evolving and more complex interactions with their surrounding environment. It is a joint function between person and their environment [230]. Thus, individuals both develop and shape contextual influences. The context itself is multi-layered, ranging from the microsystem, through to the macro-system, with the term ecological underpinning the individual's intrinsic connection to these systems. The microsystem represents the most proximal system within which the individual is situated. The interaction between two or more micro-systems forms the basis of the meso-system within which the individual actively participates. The meso-system on the other hand is one wherein the individual is not situated and does not actively participate, but that holds influence over them. Likewise, individuals are able to influence this level. The exo-system guides social policies and legislative

frameworks within which the micro- through meso-system functions. Finally, the macro-system dictates overarching beliefs and attitudes. Bronfenbrenner made an addition to the model to include the chrono-system which embodies the notion of time, and the influence of events or repeated exposures to events over time. These changes can be either normative (expected) or non-normative (unexpected events). They alter the relationships between person and environment, potentially creating a change in either [231].

In relation to sex work, this theory provides a strong underpinning for understanding the interplay between the various spheres of influence upon their lives. While this study can only measure influence at the individual level, it speaks to each level of influence. The microsystem being SWs' individual behaviours, sexual practices, their level of education and mental health concerns. The meso-system includes the places where in they sell sex and where they are sleeping. It also speaks to interactions with clients, client use of condoms and payment of services. We measure exposure to violence which is perpetrated within this level. The exo-system centres on the various policies and legislative frameworks within South Africa. Some of which criminalise the profession, and others impact upon education systems or economic growth in South Africa – which impacts employment rates. The macro-system reflects the overarching normative expectations society has of SWs, and patriarchal notions of women and the control of their bodies. Finally, the chrono-system cuts across each of these layers, making provision for the temporal nature of life, repeated exposures to violence, or changes in policy. Within this study, it is argued that the interplay between factors from each of these levels impacts heavily on SW vulnerability to HIV. Furthermore, it is argued that it is impossible to understand vulnerability without considering the intersections which exist between individual SW and environment.

3.3. STUDY SETTING

The study was conducted in Soweto, a township on the outskirts of Johannesburg, South Africa. Soweto is predominantly urban and peri-urban, low-income with limited educational and employment opportunities. It has the highest population density in South Africa, and as previously described, has an exceptionally high number of drinking establishments given the population density. There are also former-mining hostels which now function as inexpensive accommodation to roughly 40,000 residents. It is from within these drinking and hostel environments that sex work takes place. Minimal data was available on sex work in the township, including on HIV prevalence, socioeconomic, mental health nor behavioural vulnerabilities. The study was nestled within the SSWP, Perinatal HIV Research Unit based at the Chris Hani Baragwanath Academic Hospital in Soweto.

A sex work program launched in October 2013 by a Soweto-based research organisation was built on a peer education model and embraced community participation. It provides outreach services, human rights knowledge dissemination, psychosocial counselling, condom distribution, HIV testing, twice-monthly risk reduction workshops, and connections to care networks. In June 2016, the program launched a primary healthcare service which included the provision of pre-exposure prophylaxis (PrEP) for HIV-negative SWs. Their fixed clinic was used as a base for the research, with interviews conducted in private counselling rooms [232].

3.4. SAMPLE

The study population were SWs based within Soweto who were recruited in line with the inclusion criteria as per Table 2-1 (above). Recruitment took place through the SSWP and in sex work hotspots across Soweto. Soweto sex work hotspots are predominantly taverns and hostels, but also include brothels, dance clubs, and streets.

Table 3-1 Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Female	Male or transgender
Self-identified as a SW or self-identified as working within a sex work hotspot and consensually trading in sex for money or goods as her a primary source of income	Current victim of human trafficking or sexual exploitation
Working in Soweto	Part of the study team
>18 years of age	<18 years of age
HIV status known or unknown	Refused HIV and related tests
Voluntary informed consent	
Presents with a valid recruitment coupon	

3.5. STUDY PREPARATION

3.5.1 PEER EDUCATOR CAPACITY

Sex workers are a criminalised community, posing serious challenges to the recruitment of participants as they are reluctant to identify and thus implicate themselves in a criminal activity [233]. Therefore, the assistance of unskilled sex work peer educators (PEs) as interviewers and counsellors was paramount to accessing a population of SWs. The SSWP embraces a peer-led strategy for service provision and data collection across the project. All of our PEs are or have worked as SWs. They have all undertaken intensive, practical training in peer education and community mobilisation in line with the South African National Sex Worker HIV Plan, and through the SWEAT and the National Sex Work Program launched in 2013. This ensured that participants felt at ease to speak openly about their lives, sexual practices and behaviours.

Given the sensitive nature of the study, the use of sex work counsellor/interviewers encouraged participation in this study. It also reduced the likelihood of a participant experiencing discrimination or judgement by the study team. Our study team all undertook additional training in lay counselling, good clinical practice (GCP), and are certified to conduct HST. A cumulative total of 5,500 hours of

training was undertaken by the study team over an 18-month period to prepare them for the data collection.

3.5.2 QUESTIONNAIRE DEVELOPMENT

The final questionnaire was developed over a 12-month period and drew from various validated scales and questionnaires (see Table 2-3, below). A comprehensive questionnaire was drafted and presented to workshops of sex work PEs, various members of the sex work sector in South Africa, and SWs from the local community. Based upon preliminary data analysis plans, intensive workshop and individual level feedback, critical questions were highlighted. Only core aspects of the questionnaire were retained. The questionnaire was recursively assessed by both myself and my supervisors in further reducing the number of questions to ensure that the questionnaire took no longer than 60 minutes to complete.

The final questionnaire was then scrutinised by the sex work PEs both during and after study specific training, the PHRU Community Advisory Boards (Adolescent, Adult Treatment and Adult Prevention), and during through preliminary Cognitive Interviews (described below) to ensure that all questions were appropriately worded and that the time it took to gather the information was reasonable.

The questionnaire was subjected to a forward translation by an accredited translation service, and was then back translated by the study staff to ensure that the meaning had not been altered during the translation process. Concerns in the translation were highlighted and returned to the translation service

provider through a recursive process. Five iterations of the questionnaire were undertaken before the final translations into SeSotho and isiZulu were accepted.

3.5.3 SAMPLE SIZE ESTIMATE

For the primary study, we assumed that 60% of SWs had experienced violence, with 40% having no violence exposure [126]. We used a two-sided sample size calculation to detect a difference between HIV prevalence amongst the two groups. A sample size of 500 FSWs based in Soweto was assumed to provide us with 80% power to detect significance at 5% as HIV prevalence increased from 52% in violence unexposed, to 65% amongst violence exposed, as shown in Table 2-2. It was assumed that there would be more power to detect larger differences in prevalence between violence exposed and unexposed. The use of RDS necessitated a weighted analysis, with some loss of statistical efficiency. However, there was sufficient power to detect moderate to large differenced in prevalence. There was similar power to detect effects of other exposures e.g. mental illness.

Table 3-2: Sample Size Estimation based upon HIV status in violence exposed and unexposed women

		Violence Exposed	
		65%	70%
Violence Unexposed	55%	780	338
	52%	468	238
	50%	353	193

3.5.4 STUDY SPECIFIC TRAINING

All SSWP staff, a Research Nurse, and experienced counsellor were all included in the practical and theoretical training. Training followed a detailed manual which drew from the WHO training guidelines for RDS [234], and the study protocol. Templates for all data collection and monitoring tools were developed and refined during the 14-day study training. Staff undertook role plays, were familiarised with all aspects of the study to ensure that roles could be shifted as required, and were asked to work in teams to complete small test sections throughout the manual. Staff were also provided extensive opportunity to work within the REDCap data system and on the REDCap Application configured Lenovo Tablets. This ensured that they were well prepared for data collection. Substantial time was devoted to network sizes and coupon management. This was done as both of these sets of information form critical components of the data collection process and ensure that the data can be weighted for population level prevalence to be calculated.

3.5.5 COGNITIVE INTERVIEWS

Cognitive interviewing [235] were used as a tool to improve the questionnaire design. While the questionnaire was developed in conjunction with sex work community members, it was important to assess the content of questions and their phrasing before pilot testing the study. Twenty FSWs were interviewed to assess the content validity of the questionnaires. Participants were conveniently recruited through the Sisonke sex worker movement in conjunction with the SSWP. Interviews were conducted at the Sisonke offices in Braamfontein, Johannesburg in a private office. Interviews lasted an average of 1.5 hours. Participants were reimbursed R50 for their time and transport to the venue.

3.5.6 PILOT STUDY

The pilot study was conducted between October and November 2015. During this time, a sample of 8% (n=40) of the total sample size was recruited into the study using the same methodology designed for the primary study. To ensure that we did not impact upon our ability to recruit FSWs from Soweto into the primary study, the pilot sample included also SWs who sold sex outside of Soweto. The overall survey instrument, data base management, study procedures and logistics were tested during the pilot study. Final adjustments were made to the survey instrument after the pilot study was completed. The pilot study allowed for the full assessment of the RDS methodology and the REDCap database.

3.6 PRIMARY DATA COLLECTION

3.6.1 RESPONDENT DRIVEN SAMPLING

Given challenges to accessing this population for research purposes, their mobility across the township, and the inability to draw a random sample of SWs from Soweto, RDS [236] was used to recruit potential participants. The method has been used by the United States Centre for Disease Control and Prevention's (CDC) Global AIDS Program and recently in the SAMHS [16]. The World

Health Organisation developed a stringent training manual [234] on the methodology. I attended training at the WHO Training Hub, in Croatia in 2015 on this methodology.

RDS is geared to overcoming sampling bias and allowing for the generalisability of findings through data weighting based on participant network size. Standard sampling methods require the use of a sampling frame to estimate probability. However, RDS allows one to estimate the proportion of the population by adapting sampling according to the realised network of the given population. Thus ensuring that the probability of being included in the sample is nonzero and allowing the provision of asymptomatically unbiased estimates of the factors associated with HIV infection amongst SWs [237]. Much like a random sample, RDS thus allowed for the generalisability of findings from this study.

In order to develop the RDS weights, two critical pieces of information were recorded for every participant: 1) the size of their network, and 2) both participant and their recruits' coupon numbers. This information allowed chains of recruitment to be linked and appropriately weight the analyses.

3.6.1.1 SEEDS

The first people recruited to participate in the programme (known as seeds) are asked to recruit 3 SWs from their network to participate in the study. The process of participants recruiting potential participants into the study continues until the sample size is reached. According to the literature, the longer the chains of recruitment emanating from a seed, the more stable and independent the characteristics become from the original seed. Thus the more different the SWs' characteristics will be between the seed and the final recruit on that chain. Through real time monitoring of recruitment, we were able to assess the stability of our recruitment chains and decide whether or not to include new seeds.

The recruitment of study seeds took place through the SSWP. “Chief” or matriarch SWs within Sowetan sex work hotspots were identified as strong candidates to be potential seeds. This was done by peer educators from the local sex work programme. “Chief” SWs are gate keepers within sex work hotspots, their networks were larger and more expansive than other SWs in the community. Using peer educators 20 women were identified as fulfilling a matriarchal role. Potential seeds needed to have a network >15 female sex work seen in the past 2 weeks, be diverse in age, and be based in different suburbs across Soweto. Based upon these factors, 15 women were selected as potential seeds. This ensured diversity amongst the seed sample population. Of these 15 identified potential seeds, the 5 strongest seeds were contacted at the start of the study in January 2016. Three seeds were initially planted on the 8 February 2016. “Due to several consecutive public holidays in South Africa, recruitment slowed substantially in weeks 7–11, and a further seven seeds were located using existing participants and sex work counsellors/peer educators from geographic areas not yet reached by the sex work program. They were introduced into the study between weeks 13 and 15. This had the advantage of increased diversity among the seed sample and allowed for seeds to be selected who had not been part of the local sex work program” [146].

3.6.1.2 RECRUITMENT

Each seed was provided with three uniquely coded coupons which they gave to the individuals that they recruited. Coupons were carefully managed using an excel spreadsheet which automatically generated coupon codes, monitoring recruitment chains and ensured reimbursements were appropriately paid. This ensured that we could track subsequent recruitment from an original seed. Successful recruits were themselves provided with coupons to recruit, thus creating waves of recruitment. The maximum wave length was 25 waves. A total of 11 seeds were recruited into the study. Two were highly productive, yielding >80% of the total sample. Four were minimally productive, with the remaining five being non-productive seeds.

To manage sample growth, a maximum of 3 coupons were provided to each participant until we reached 490 enrolments. Thereafter only 1 coupon was provided until the sample size of 500 was reached and following this, no coupons were given out. This recruitment strategy was also assumed to ensure that we reached SWs unlikely to be recruited through conventional recruitment methods and to ensure diversity across the sample. This was done through selecting seeds of varying ages and primary sex work suburb. The selection of seeds from various suburbs also had the effect of ensuring that we accessed SSWP unexposed SWs.

3.6.1.3 SEX WORK SPECIFIC SCREENING

To ensuring that only FSWs were enrolled into the study required that their status as a SW was identified during enrolment. This was done using three strategies, with the third being used only when the screener was uncertain of their engagement in sex work. Firstly, screening was conducted by a skilled SW counsellor. Secondly, primary screening was done directly into the REDCap data management system and assessed the basic inclusion criteria, including asking about whether the person engaged in sex work. Finally, for individuals suspected of being non-SWs, a secondary screening using undertaken. This included using SW-specific discourses to probe more the individual's knowledge of and participation in typical sex work activities. To avoid duplicate enrolment of women referred to the site by multiple recruiters, all participants were fingerprint scanned on their left, index finger. Only one participant could not be enrolled due to severe callousing on her hands. The algorithm was recorded into the FingerTec OFIS system (http://www.fingertec.com/images/brochure/Ofis-E.pdf) and compared to all subsequent enrolments.

3.6.1.4 RDS STATISTICAL ASSUMPTIONS

RDS assumptions were monitored using specialist software (RDS-Analyst). This was done both during data collection, and as a confirmatory assessment when developing prevalence estimates. Confirming that all assumptions are met is critical in ensuring that RDS data can be weighted using

the network size information. This allows for prevalence estimated to be generated which are generalisable. Core variables assessed included HIV status, age, exposure to violence, and depression (as a proxy measure of mental health).

Homophily: or purposefully recruiting individuals with similar characteristics, was assessed using the ratio of recruits to recruiters who had a corresponding characteristic (e.g. HIV status). This served to ensure that the number of homophilous pairs was close to the equivalent in the sample population of what would be expected to occur by chance [234]. Within this study, the homophily for any core variable was well within appropriate ranges (0.9-1.2)

First Order Markov Process: also, known as convergence or equilibrium across the sample was assessed. This is used to indicate that the purposive selection of the initial seeds, did not bias subsequently enrolled recruits into the study. Convergence was achieved between waves 7-10 of recruitment for primary variables [234].

Reciprocity: RDS assumes that if participant A reports participant B to be part of the network of SWs in Soweto, that participant B would also be able to report participant A as being a member of this same network. At enrolment, participants confirmed that an existing relationship existed between themselves and their recruiter. This allowed us to assume that reciprocal relationship existed. [234].

Degree: We assumed that FSWs could accurately estimate their network size (degree). Our counsellors were trained to carefully assist participants to do this through asking several questions. Firstly, participants were asked “how many FSWs they know and who know them. Of these, how many of these were women? Of these, how many sold sex in Soweto? Of these how many were >18 years of age. Of this final value, how many had they seen in the last 2 weeks”. This final value represented their network size. Counsellors were trained to make paper and a pen available for

participants to jot down notes on in assisting them to calculate their network size. They also knew that each subsequent value given needed to be smaller than the previous value as it was a component of this. So, should the number be greater than the preceding response, the counsellor needed to probe around this and if required, re-ask each of the questions.

Recruitment from peer to peer is random: when given coupons to recruit other potential participants into the study, a participant was instructed to: "recruit other women who like you sell sex in Soweto. She should be someone you know, and you can give any of the women you know the coupon at random. So not necessarily the first person you see". In addition, they were told that their coupons should only be handed out the following day, to prevent them from leaving the site and giving it to the first person they saw.

3.7. DATA COLLECTION

3.7.1 STUDY PROCESS FLOW

The screening form was completed for every potential participant screened according to the primary inclusion criteria. Secondary screening was undertaken on individuals suspected of being non-sex work capitalising on the study. Potential participants who met the inclusion criteria undertook voluntary informed consent through the Screening Manager and were enrolled into the study. For those consenting, data collection then began as per Figure 3-1. All procedures were conducted in a private counselling/testing room at the SSWP offices. Interview and HST data was captured by a certified HST counsellor who was also a sex work

peer educator. Once all HST had been undertaken, the coupon manager provided each participant, now known as a recruiter, with their allocation of coupons.

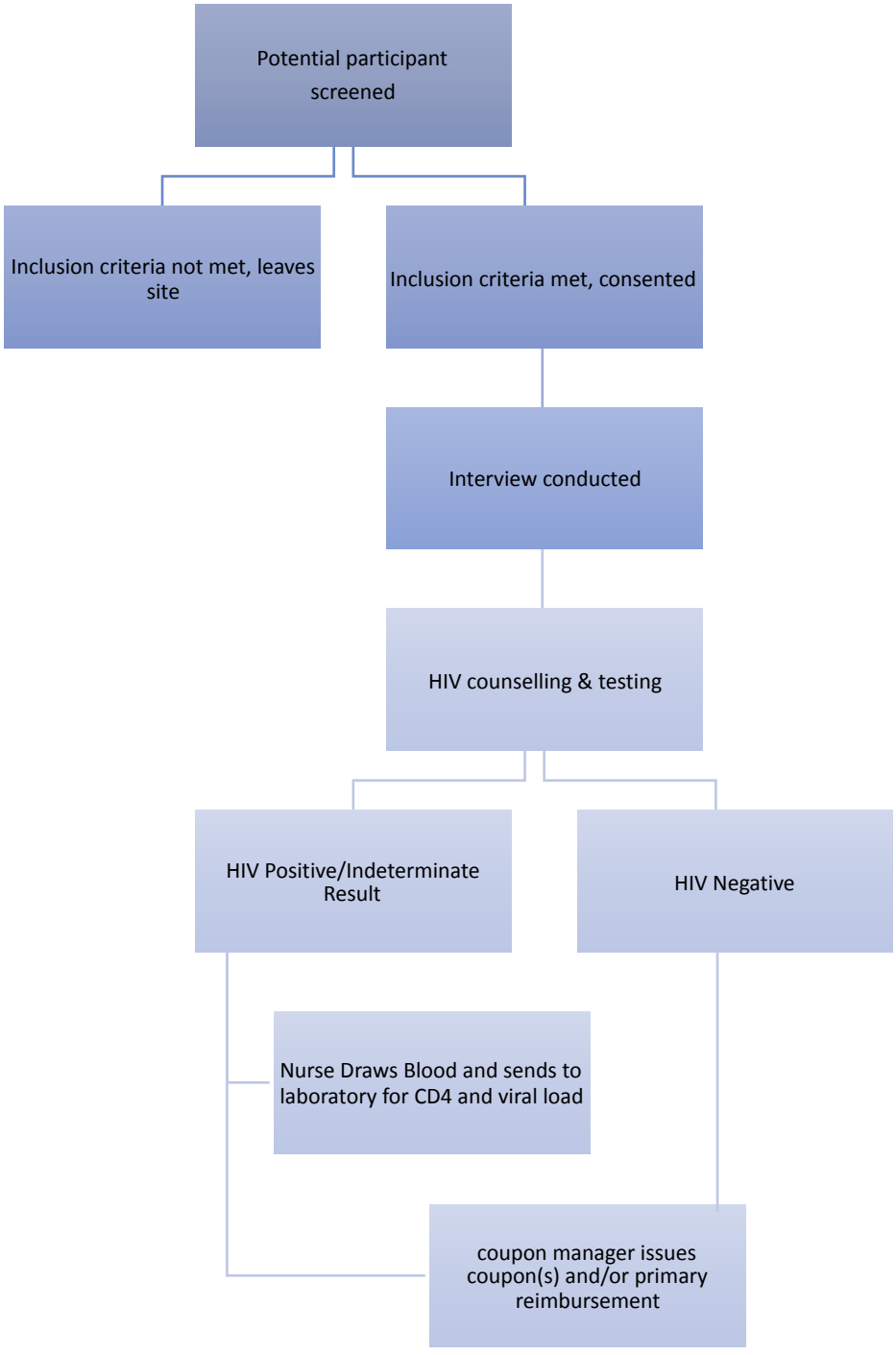

Figure 3-1: Process flow for study participants and data collection

3.7.2 SURVEY INSTRUMENT

Survey tools were selected based upon existing evidence of their being culturally appropriate, having been validated for use in South Africa or within low-income countries by the World Health Organisation, for ease of adaptation to the sex work context and ease of administration by PEs, and finally for their potential relevance in understanding HIV infection amongst FSWs. Table 3-3 shows all survey tools used within the study. The survey instrument was finalised in consultation with members of the sex work community, Perinatal HIV Research Unit Adult Treat and Preventions community advisory boards (CABs) and the adolescent CAB, and SSWP counsellors and peer educators to ensure that each element was appropriate to sex work contextual dynamics and that the terminology included was appropriate. More than 100 hours was spent working through the questionnaire with community members to insure it is appropriately adapted for the sex work community. Translations were done and certified through a reputable translation agency. They were then interrogated by the PI and study staff to ensure that the meaning of questions and response sets had not been altered. Changes were made to the translations in conjunction with the translation company before being accepted and uploaded into the questionnaire.

Table 3-3: HIV status and comprehensive assessment survey, including variable descriptions

Variable Name	Measure	Details
Demographic Characteristics	Existing SSWP demographics questionnaire	This section draws from the brief demographic questionnaire currently used by the SSWP in combination with an existing instrument devised by the PHRU. It assessed basic background and demographic information such as age, gender, ethnicity and schooling. In addition, it assesses household, water status and availability, and living conditions. Questions are scored as single items.
HIV testing history and risk perceptions	HIV testing history and risk perception	HIV testing behaviour including reasons for testing or not testing, self-report HIV status and ARV uptake were assessed. A risk perception tool was adapted from a previous study with male sex work [221] items are scored on a 4-point-likert scale. 1” safe” 2 ”probably safe” 3 “unsafe” 4 “do not know”.

Childhood Experiences	Childhood Trauma Questionnaire (short version)	A modified version of the CTQ which measures 5 dimensions: neglect (physical and emotional) and abuse (emotional, physical and sexual), is used. We added questions on female circumcision which has been highlighted during the first year of the SSWP as possibly being prevalent amongst certain ethnic groups in South Africa. These items will not be scored with the CTQ scale.
Intimate partners	Intimate partner characteristics	Questions were asked about intimate partners, including their age, gender, employment status and drinking
Pregnancy and Children	WHO SRH questionnaire adapted [222]	Asks about most recent pregnancy, overall pregnancies, contraceptive use and termination of pregnancy.
Exposure to Violence*	WHO violence against women adapted for sex work [223]	WHO Violence Against Women instrument was adapted for sex work, and assesses violence (physical, emotional and sexual) perpetrated by a primary partner/boyfriend, clients, establishment owners, security, police and unknown male.
Sexual Behaviour*	Primary and non-primary partner questions, dry sex practices. WHO sexual and reproductive healthcare questionnaire [222]	Adaptation of the World Health Organisation (WHO) Adolescent sexual and reproductive health survey [222], and which has previously been used in a study of sex work [111, 224]. The new instrument documents knowledge, beliefs, testing behaviours, attitudes and outcomes of sexual health behaviour by SW, length of time as a sex work and sex work sexual practices based upon a study of male sex work which indicate types of sex acts common in SW. All items on this scale are scored singularly. Certain items can be summed.
Mental Health	CES-D [225]	Depression and suicide ideations are assessed. CES-D scores: 16 is the cut-off sore for symptoms suggestive of depression, >21 is highly suggestive of depression.
	PTSD-8, a short PTSD inventory based upon the Harvard Trauma Questionnaire[226]	A 4-point likert scale is used to rate 8 items on whether participants were bothered by various symptoms directly linked to the DSM-IV PTSD criteria. Scores are totalled and averaged to derive the cut-off. This is then used as a threshold for PTSD. Scores >3 for any of the 3 items (intrusion, avoidance or hyper-vigilance) are indicative of PTSD symptomology.
	Rosenberg's Self Esteem Scale[227]	10 items are scored on a 4-point likert scale. Scores are reversed as appropriate and tallied. A high total score is indicative of a high self-esteem, low score with low self-esteem.
	Deliberate Self-Harm Inventory [228]	A 17-item behavioural self-report questionnaire (α=.82). Frequency is measured continuously, any engagement in self-harm on items 1-16 are dichotomised into self-harm or no self-harm. Items can be used individually.

Alcohol and Drug Use	Alcohol Use Disorder Identification Test (AUDIT)[229]	The types and frequency of alcohol, drug and cigarette use is assessed. Items are scored singly.

3.7.3 HIV STATUS AND DISEASE PROGRESSION

Following on from the survey instrument and in line with WHO Guidelines [238], two rapid assays were conducted to ascertain participants' HIV status. These were supplied by the South African Department of Health (DoH) (Abon™ and First Response™ were the rapid tests supplied). All finger prick testing was done by a certified HST counsellor. Blood plasma for HIV positive participants was drawn by a qualified nurse. In line with the 2014 South African treatment guidelines, anyone with a CD4 count ≤ 500 cells/mm^3 was immediately referred for treatment through the SSWP referral network[239]. This was revised in June 2016 when universal test and treat was made available to all SWs[59].

For confirmation of indeterminate results, an enzyme-linked immunosorbent assay (ELISA) (including a CD4 count and viral load, as appropriate) was conducted. All viral loads were undertaken through the Central Laboratory Systems (CLS), with CD4 counts being run routinely using the National Health Laboratory Service (NHLS). All CD4 tests were done using the PanLeucogating (PLG) technology for CD4 enumeration through the NHLS. Viral load was measured by CLS on the Abbott RealTi*m*e HIV-1 assay. "Drug resistance genotyping was undertaken by the National Institute of Communicable Diseases (NICD). Sequencing of the polymerase gene was performed using a validated in-house assay [240]. The procedure involved the generation of a nested PCR amplicon spanning the entire protease and p66 and p51 regions of the reverse transcriptase genes. Genotypic resistance was defined as the presence of resistance mutations associated with impaired drug susceptibility, using the Stanford University HIV Drug Resistance Database (https://hivdb.stanford.edu/). Phylogenetic analysis of nucleic sequences was performed using an HKY85 model to establish linkages using PAUP, and rates of transmission of resistance

determined by calculating point prevalence with confidence intervals" [2]

3.7.4 QUALITY CONTROL MECHANISMS

Intensive training was implemented for all study staff in preparation for this study. This included >5,000 hours of training for GCP, HST, research skills, data capturing and interview skills and one weeks of study specific training. This intensive staff development assisted in ensuring high quality data collection, familiarity with the REDCap database, and reduced experimenter expectancies to ensure more accurate information was provided by participants. The use of sex work counsellors was observed to reduce social desirability bias and anxiety at participating in the study as participants concerns about being discriminated against were mitigated.

QUALITY CONTROL MECHANISMS

- ✓ Quarterly NHLS HST quality assurance (every assessment passed).
- ✓ Validated CD4 and viral load tests were undertaken by certified and approved laboratories. Viral load test kits were provided by CLS. Each kit had been prefaced and labelled to ensure accurate reporting. A CLS and/or NHLS barcode attached to every participants' checklist form and signed by the nurse.
- ✓ Data was captured directly into the REDCap software version 6.2.5 © (2015, Vanderbilt University). This allowed for built-in algorithms, skip patterns and prompts to further improve the quality of the data captured.
- ✓ 12% duplicate data collection with a final error rate of 0.6%
- ✓ Biometric fingerprint scanner prevented duplicate enrolment.

3.7.5 DATA MANAGEMENT

Data was captured directly into the REDCap data management system by the trained counsellors. Identifying information captured onto the REDCap system was automatically omitted from data exports. Data was linked using the unique coupon number that the participant had presented with at the study site. Data was captured live into the database and could be monitored on a real-time basis from a remote location. This ensured that responses to interviewer queries could be addressed relatively quickly. Data was exported and cleaned using STATA 13[241]. Questionnaire data was reverse coded and scored as appropriate. The majority of the STATA coding was written in advance

of the study to ensure that the three databases (English, Zulu, SeSotho) could be merged and RDS assumptions could be assessed weekly using RDS-A [242].

Cleaned and recoded data was exported from STATA for analysis in the RDS Analysis Tool (RDSAT) software (Version 7.1, www.respondentdrivensampling.org). RDSAT version 7.1 uses the RDS-II estimator [243]. RDSAT analysis allowed for an adjustment to data for social network size and homophily in networks. This was used to produce population point prevalence estimates and 95% confidence intervals of key variables, adjusting for non-equal probabilities of inclusion. The RDS-II estimator was also used in RDS-A to develop the weights, which were subsequently exported and used within STATA multivariate analyses as described within Chapters 4-8.

3.8. ETHICAL CONSIDERATIONS

All GCP and ethical procedures were followed throughout the study in line with the overarching SSWP (M131123) HREC approved protocol and this study protocol (M150736) (Addenda A). All due ethical considerations for this study were strictly adhered to. The researcher was cognisant that the individuals participating are part of a marginalised and highly stigmatised population. Care was taken during the development of the study protocol, study SOP and training to ensure that ethical considerations were given preference, including using the WHO Guidelines[244, 245]. Table 3-4, below, outlines ethical considerations which guided the study. In completing this thesis, all relevant citations were included and a turn-it-in report created to confirm no plagiarism (Addenda B).

Table 3-4: Mitigating risk for ethical considerations

Ethical Consideration	Action taken
Confidentiality & Anonymity	Data was anonymous, and linked via de-identified participant numbers (coupon numbers). However, anonymity could not be guaranteed due to the sampling strategy, which requires that participants recruited potential participants for screening. As such, a recruiter knew her recruits, who could potentially have participated. Data collection was done within the offices of the SSWP Wellness Centre. This meant that anyone coming into the centre and who knew about the study, could potentially have identified individuals participating in the study. Confidentiality would be breached if required by law. This was stated within the VIC form. No breaches were made throughout the duration of the study.
Emotive nature of interviews	The survey asked some very personal and emotive questions about sexual behaviour and violence. The VIC expressly stated as much and provided examples of the kinds of questions which would be asked to enable potential participants to make a decision on their participation. All interviewers were provided intensive training on counselling through the Family Life Centre (FAMSA), and were well equipped to assist any distressed participant. The SSWP provides sex worker friendly services by SWs to SWs. The team was very well equipped and experienced in dealing with serious emotional and social issues. Linkage to care was provided through the network of service providers established in the SSWP. This included FAMSA, Ntabiseng Trauma Care Centre, Lilian Nagoya Clinic (health concerns), and Zola Clinic (termination of pregnancy), SSWP (PrEP, ART & STI treatments available from June 2016). Across the study, referrals were made for post rape care, trauma counselling, ART and PrEP initiations, and termination of pregnancy. Trauma counselling and ART referrals were the most frequent.
New HIV diagnosis	Individuals who were newly diagnosed with HIV or who were distressed for whatever reason about their known status were provided with our standard care through the SSWP. We have extensive experience assisting SWs with HIV results, adherence counselling and appropriate safer sex counselling during HST.

Safety at the study site	Careful planning was put into place to ensure staff and participant safety during the study. Planned study process flow was scrutinised to ensure that challenging potential participants were kept away from data collection areas and could be contained and managed. Role plays were developed to assist staff with preparing for a difficult participant who could disrupt the site. A security gate with fingerprint access was installed to ensure that the data files, cash and computers/tablets could be secured. It also functioned as a planned safe zone. A full day of training was dedicated to study safety and an SOP was developed to ensure staff followed protocol should any concerns arise. This included the following: ➢ Coupons did not include inclusion criteria, and made no mention of sex work. They offered to a Women's Health study. ➢ Counselling/Interview rooms were carefully set up to ensure that staff were closest to the door for a quick exit if required. ➢ A code word was developed by the staff so that they could discretely alert other staff to a potential problem without alarming participants and other SSWP users. ➢ Drunk or high potential participants were asked to return for screening at a later date and provided with an appointment card.
Working with women and violence	We were cognisant that we were working with a group of women heavily exposed to violence. This required careful planning and meaningful discussions with community stakeholders in the roller of the project. Site safety was paramount in the event of retribution violence by an intimate partner, client, establishment owner or the police. Participant safety was of the utmost importance and was ensured throughout the study through various steps as discussed across this component of the report. Further to this, staff were offered ongoing debriefing through the FAMSA, and internally through group debriefing meetings. Many of the staff had entered into an ongoing debriefing relationship with a therapist prior to the commencement of the study.
Addressing stigma and discrimination	The SSWP and the PHRU took steps to reduce the risk of any participant experiencing discrimination while at the study site or on referral. All staff were sensitised to SW concerns using the Desmond Tutu Sensitisation Manual for SWs [238] Our nurse had worked closely with the SSWP team prior to this study. The wellness centre wherein the study was conducted was carefully managed to ensure that it was a safe and non-discriminatory space. It was specifically geared to key populations. All participants were handled with respect and dignity and in line with GCP guidelines. No reports of discrimination were made by participants during or after the study.

Data security via REDCap	All data collected was coded within the REDCap online data system. All tablets and computers were password protected as was access to the REDCap application. Personally identifying fields were marked as personal information and cannot be exported from the REDCap system. The use of the REDCap system was well monitored within this study, and access was only provided to staff who have been specifically trained and registered onto the system. Further, access was through a secure network from password protected computers which undergo quarterly password changes. Passwords included a minimum of 8 characters with 1 each of a capital letter, symbol and number. Thus, they were unlikely to have been deciphered. The REDCap online system has various security measures in place to assure the safety of data stored on their servers, and has been approved for use by the University of the Witwatersrand.
Accidental exposure to HIV	The PHRU SOP for the accidental exposure to pathogens was reviewed with all staff to ensure that they knew exactly how to handle such a situation. No accidental exposure occurred during this study.

3.8.1 VOLUNTARY INFORMED CONSENT

Participation in the study was completely voluntary. In ensuring voluntary informed consent was achieved, all potential participants read (or were read) the information sheet prior to consenting to participate. They were required to sign a consent form. The informed consent process was available in either isiZulu, SeSotho, or English, at participants' preference. An independent witness was required during the consenting of some participants to confirm that the information sheet was read, discussed, all questions answered, that the participant understood the study and has given consent.

All clinic data was maintained within clinic files at the SSWP Wellness Centre for the duration of the overall SSWP programme. Survey data will continue to be stored for the duration of the SSWP programme or for 10 years from the date of final collection (8 September 2016) as it will continue to provide valuable insights into the needs of the population and potential mechanisms to address these through the overall programme. No biological samples were stored.

3.8.2 REIMBURSEMENT

In line with all PHRU biomedical and socio-behavioural studies and in response to the budgetary considerations of this PhD study, participants were provided a primary reimbursement of R100 (7$) for costs associated with participation in the data collection. A further secondary reimbursement of

R20 (in cash or airtime) was paid to participants who were provided with coupons and who successfully recruited potential participants into the study. A maximum of R60 (4$) was paid to any one participant. An additional R20.00 was added to both primary reimbursement (R120) and secondary incentives (R120 maximum incentive) 4 months into the study in response to increased costs to participate within the study. The additional secondary incentive worked on a sliding scale in relation to the time period from the coupon being issued. Recruiters received the R20 secondary incentive as well as:

- R20.00 for a participant enrolled 3-4 days of coupon issuing (R40.00)
- R10 for participant enrolled 5-7 days within coupon issuing (R30.00)
- No additional secondary incentive for participant who returned >7 days later (R20.00)

Secondary reimbursements were only paid to the recruiters if the following conditions were met:

1. The recruit was successfully enrolled into the study
2. The recruit completed all study related activities required to receive a primary incentive

Participants who requested, were provided transportation to and from the SSWP offices. All clinic and study information was locked in a secure filing room with fingerprint access control.

The methodology developed for this study in consultation with the sex work community of Soweto yielded interesting findings. It highlighted the importance of engaging the community during all aspects of research projects to ensure that data collection could be meaningfully implemented. Overall the success of this study highlighted the importance of including SWs onto the study team, and the ability of low literacy individuals to implement high impact research if given the opportunity. The next five chapters each present a component of the research undertaken by this study team and in responding to the overall aims of this research project. Chapter four will present a description of

victimisation and polyvictimization of FSWs, highlighting the importance of violence prevention interventions as a central component of HIV prevention efforts. Chapter five will elaborate on the mental health needs of this population as well as its impact upon HIV vulnerability. Chapter six will present HIV prevalence and associated factors, while describing the demographic profile of SWs in Soweto as well as some of their sexual practices. Chapter seven will then explore HIVDR amongst this population and flag the need for greater clinical oversight within the roll-out plans for the South African National Sex Worker HIV Plan 2016-2020. Finally, chapter eight will present a model of vulnerability through which to understand the role of mental health and violence in relation to HIV.

4. CHAPTER FOUR: PREVALENCE AND PATTERNS OF VICTIMISATION AND POLYVICTIMIZATION AMONGST FEMALE SEX WORKERS IN SOWETO, A SOUTH AFRICAN TOWNSHIP: A CROSS SECTIONAL, RESPONDENT DRIVEN SAMPLING STUDY

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Table 4-1 Author Contributions Paper One

AUTHOR	CONTRIBUTIONS
Jenny Coetzee	Conceptualisation, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, resources, software, software, supervision, validation, visualisation, writing – original draft, writing – review & editing
Glenda E Gray	Conceptualisation, investigation, methodology, supervision, writing – review & editing
Rachel Jewkes	Conceptualisation, investigation, methodology, supervision, writing – review & editing

4.1 ABSTRACT

Background Sex workers (SWs) are disproportionately affected by violence from multiple partner categories. This increases their vulnerability to HIV.

Objectives To describe patterns of violence and polyvictimization amongst female SWs in Soweto.

Methods A respondent driven sampling(RDS) recruitment methodology was used to enrol 508 Soweto-based FSWs using a survey instrument. Raw and RDS adjusted data were descriptively analysed, Spearman's correlation and chi^2 test of association were used to show associations. Polyvictimization patterns are shown within a modified Venn diagram.

Findings The median age of FSWs in Soweto was 31 years, and most had an incomplete education (74.2%). The prevalence of exposure to physical/sexual intimate partner violence (IPV), in the past year was 53.8%, 46.8% by clients, and 18.5% by police. Past year prevalence of sexual/physical violence by any perpetrator category was 70.8% and lifetime exposure was 76.0%. Childhood sexual violence was reported by 44.3%. Lifetime non-partner rape was 55.5% and all rape exposure was 62.4%. As a result of engaging in sex work in the past year, 65,2% women had been discriminated against. Client, police, IPV, and childhood trauma were all significantly associated with one another, with IPV being the most common co-occurrence. Polyvictimization was seen in almost two thirds of FSWs, and increased with exposure to discrimination.

Conclusion In Soweto, FSWs are exposed to high rates of violence in multiple forms across their lifetime. Our findings show that violence continues unabated into adulthood at levels far higher than in the general population and overall at higher levels than previously recorded amongst SWs in South Africa. We argue that violence against FSWs is rooted in discrimination. The disparate burden of violence on FSWs requires urgent interventions to proactively address and reframe the

normalisation of violence against all women. Key Words: sex work, South Africa, violence, client violence, intimate partner violence, hate crime

4.2. BACKGROUND

Sex workers (SWs) epitomise South Africa's dual human immunodeficiency virus (HIV) and violence epidemics [1-3]. Despite a constitution lauded internationally for being grounded in human-rights and equal rights for women[4], the country is highly patriarchal with pervasive violence against women [5]. Evidence confirms the high exposure female sex workers (FSWs) have to violence. A study of FSWs in Soweto, South Africa, showed that 53.8% and 55.6% had experienced intimate partner and non-intimate partner sexual violence in their lifetime (respectively). In Johannesburg, 20% of FSWs reported experiencing sexual violence, while 54% reported any physical violence in the past year [1, 6]. Globally, violence is associated with inconsistent condom usage, sexually transmitted infection (STI) and HIV acquisition, undermining economic capital, and it has a widespread social impact [7-11]. The resulting mental health complications, including post-traumatic stress disorder (PTSD), and depression, often undermine individuals' effective functioning [11, 12]. This may result in substance abuse or a lack of adherence to chronic medications such as antiretroviral therapy (ART) [13]. For these reasons, it is important to understand exposure to violence and the multiple forms of violence FSWs may be exposed to across their lifetime to ensure that programmes can be effectively equipped. Little is known about the patterns and prevalence of victimization and polyvictimization amongst SWs in South Africa . Given the launch of the *South African National Sex Worker HIV Plan 2016-2020 [14]* and the scale up of sex work programs across the country, understanding the trauma experienced by this neglected and marginalised population is important to developing effective interventions.

South Africa's socio-political history has fostered and normalised a culture of violence and inequality. The apartheid Government sponsored violence, while state policies exposed millions of

men and boys to humiliating, brutal and violent police and prison practices. Alongside this there were limited and discriminatory resource allocations, poor education systems and fragmented family structures, with institutionalised racism leaving a legacy of low self-worth. This violence was underpinned by notions of male superiority through intrinsically patriarchal values. One response amongst those most on the receiving end of apartheid violence, was the creation of more violent masculinities predicated on toughness, superiority, and sexual entitlement [15]. In contradistinction are models of respectable femininity that encourage subservience [5, 16, 17]. These masculinities persist to the present day, and male violence is still used to enforce male dominance and control, while punishing female transgressions [17-20]. Such relationship inequities result in greater vulnerability to HIV through increased and prolonged exposure to men who engage in violent and sexually risky behaviours. In a context where social norms discriminate against SWs and position them as a devalued population, this is compounded, while sex purchasers are not as socially condemned.

Evidence has shown the association between men who purchase sex and engaging in IPV, rape, multiple concurrent partners, binge drink, and refusal to use condoms [21-23]. They are also physically and sexually more violent towards women than are men who do not purchase sex [24] and men who engage in intimate partner violence (IPV) are more likely to be HIV positive [25]. This highlights the vulnerability of women selling sex to violent and often HIV positive men. Perpetration of violence by sex buyers is supported through a lack of emotional connection, stigma and patriarchal entitlement [23, 26]. While men desire relationships with women they respect [27], and SWs are not considered to be respectable women [28, 29]. Furthermore, the stigma associated with sex work, functions to increase the risk of IPV through the objectifying these women [30]. In South Africa SWs describe being treated as if they were not human beings [31, 32]. Together with patriarchal norms and aggressive masculinities, these factors function in important ways within a sex work-HIV epidemic. Firstly, violence is used to punish women who transgress traditional gender

norms [17, 23], or who attempt to dictate the terms of a relationship and thus threaten male authority [20]. Secondly, SWs are not respected as women because they are seen to be 'paid for' [28], thus reducing male pride centring on sexual conquests, and positioning the FSW as being 'owned' by the paying partner. Finally, unlike a situation that can be found in intimate relationships, a sex exchange relationship offers no emotional protection from violence. These factors then result in perceived transgressions being punished through violence. SWs are not considered to have the right to give consent or to choose who she sells sex to, by clients, managers, police and healthcare officials alike [6].

Data from a very deprived township north of Johannesburg CBD, South Africa and with similar conditions to those experienced by SWs in Soweto, found that 38% of men reported perpetrating sexual assault, and 54% engaged in both physical and sexual violence in the past year [33]. These findings highlight the normalisation of violence and that perpetrators feel impunity for their actions. For example, in Gauteng, more than half of women (51.3%) from the general population report experiencing some form of violence in their lifetime: 43.7% report emotional abuse, 33.1% physical violence and 23.5% sexual violence [34]. There is limited information available on exposure to violence for FSWs. The 2013 South African Health Monitoring Survey (SAHMS) asked two condensed questions about experiences of physical or sexual violence in the past year, finding physical and sexual violence to be 50.9% and 21.9%, respectively, amongst Johannesburg-based FSWs [1].

Experiences of violence in childhood are a known risk factor for later revictimisation, including IPV [35, 36]. The risk of IPV increases through witnessing violence against a mother [37], and experiencing sexual violence in childhood [18]. A 2013 study found a three-fold increase in gender-based violence amongst women who had experienced childhood violence [36]. Globally, evidence has also shown levels of childhood sexual abuse amongst FSWs to range from 32.4%-42.0%, and

that sexual abuse in childhood is higher amongst SWs than other women [38, 39]. Experiences of violence in childhood, normalise dysfunctional behaviours, and distort expectations of power. The trauma also affects the physiology of the brain, impacting upon emotional stability and relationship formation in adulthood, promoting vulnerability to violence [18].

Evidence suggests that across South Africa, as many as one in eight women (13.8%) experiences IPV in the past year [40]. In Soweto, 50.4% of women from the general population reported lifetime exposure to IPV and one third reported IPV in the past year. Many women experience multiple violence types by an intimate partner[11]. Evidence suggests IPV is more common amongst women who report transactional sex [41]. Little is known about SW exposure to IPV in South Africa. One study found that 19% of SWs interviewed had been raped and 63% had been beaten by their intimate partner [42]. A Kenyan-based study found that 79% of FSW had experienced some form of IPV in the preceding 30 days, which was associated with inconsistent condom use [43].

Some research exists on violence perpetration by police and clients of SWs in South Africa. In Cape Town 12% of FSWs reported ever having been raped and 47% ever threatened with violence by the police. Evidence suggests that SWs who attempt to report sexual violence to policing officials are frequently re-victimised by the police [6]. A 2011 qualitative study found that sexual violence perpetrated by police and clients was common [32]. Research has also found that 37% of street-based SWs and 20% of brothel-based SWs had experiencing some form of client violence in their lifetime [6]. The vulnerability of SWs to violence is complex and requires more knowledge in developing an understanding patterns and prevalence of violence.

Modelling estimates have suggested that through addressing violence amongst SWs, 25% of HIV infections amongst this population could be averted [44]. Despite this, there is limited evidence on the (re-)victimisation and polyvictimization of FSWs in South Africa. Available literature suggests that SWs are particularly vulnerable to violence perpetrated by clients, and police. Yet, there is

inadequate information on re-victimisation by these perpetrator groups, nor the overlap with other forms of violence.

Our study aims to describe the prevalence of violence by perpetrator category and violence type, as well as patterns of victimisation and polyvictimization, amongst FSWs in Soweto, South Africa. We hypothesised that FSWs in Soweto South Africa experience higher levels of intimate partner violence and sexual abuse by any perpetrator than had previously been shown amongst women from the general population, and previously reported for FSWs in South Africa. Finally, we hypothesised that FSWs would experience substantially more childhood trauma than recorded for the general population.

4.3 METHOD

Our cross-sectional study was conducted in Soweto. The locale is predominantly urban and peri-urban, low-income with limited educational and employment opportunities. It has the highest population density in South Africa: an estimated two million inhabitants within >40 suburbs across 61km^2. Eleven apartheid-era former single-sex, and ethnically segregated hostels house an estimated 40,000 residents. A sex work programme was launched by the Perinatal HIV Research Unit (PHRU) within the township in October 2013. Their fixed clinic was used as a base for the research [45]. Formative work included cognitive interviews (n=12), and a pilot study (n = 40) [45, 46]. The full methodology has been extensively described in previous research [46].

Inclusion criteria for the main study were: biologically female, over 18 years, currently sold sex in Soweto, knew their recruiter, and gave voluntary informed consent to participate. In determining sample size, a two-sided calculation was used to detect a difference between HIV prevalence among FSWs presumed to be exposed to violence versus those unexposed to violence. A sample size of 500 was estimated to ensure sufficient power of analysis.

A respondent-driven sampling (RDS) recruitment strategy was used [47]. The method is a popular way to recruit marginalised populations for population-level estimates [48, 49]. A total of 11 seeds (initial participants) were used during the study to recruit 508 FSWs between February and September 2016. Similar to a chain referral method [48], all participants (including seeds) were given three coupons with which to recruit potential participants. Seeds and subsequently enrolled participants were asked to give the coupons to randomly selected women they knew and who knew them, who, like themselves, sold sex in Soweto, and who were older than 18 years. Recruitment chains were mapped between each seed and all subsequent recruits[49, 50].

After screening, participants gave their consent to participate in the study, and then completed a 45-minute, interviewer-administered questionnaire in English, isiZulu or SeSotho. Participants were then given a maximum of three uniquely coded coupons and reimbursed R100.00 ($7.69). A further R20.00 ($1.56) secondary incentive for successful recruitment was paid 7–10 days later. Primary reimbursement and secondary incentives were increased five months into the study to cover additional costs to participate[46].

Data were captured directly onto Lenovo tablets using the REDCap electronic data management system [51], hosted by the University of the Witwatersrand, South Africa. The database housed built-in skip patterns and algorithms. Duplicate data were collected on a convenience sample of 12% of the final sample size with an error rate of 0.6%. Ethical approval was provided by the Human Research Ethics Committee (Medical) of the University of the Witwatersrand, South Africa.

This study draws from an ecological model of understanding violence amongst SWs [52]. Various levels of influence exist within the environment, from the macrosystem which encompasses legal frameworks, and patriarchal and masculine identities, to the exosystem including the hostels, taverns and brothels wherein sex is sold, the health and policing systems. Finally, there is the individual level (micro system) experienced of violence perpetrated by clients, police, intimate partners, or

experienced during childhood. These spheres of influence function to drive and maintain vulnerability to violence.

4.3.1 MEASURES:

Violence was assessed using the World Health Organisation violence against women questionnaire [53] adapted to ask about violence specific to various perpetrator types. This included IPV, police violence, and client violence. Emotional violence was only asked in relation to intimate partners and included questions such as: "within the past year did any partner insult you or make you feel bad about yourself", and "Within the past year did any partner threaten to hurt you?". In assessing physical violence, questions included: "Within the past year did any [partner/client/police] hit you with a fist or with something else (such as a beer bottle, stick or belt) which could hurt you?" and "Within the past year did any [partner/client/police] kick, drag, beat, choke or burn you?". For sexual violence, questions included: "Within the past year did any [partner/client/police] physically force you to have sex when you did not want to?" and "Within the past year did you have sex with any [partner/client/police] when you did not want to because you were afraid of what he might do?"

All forms of violence were assessed by perpetrator category before moving on to the next perpetrator category. Questions were scored on a 4-point scale ranging from 1 "none" to 4 "many". Items were dichotomised as some versus no, to create seven new variables showing past year intimate partner emotional abuse, or physical/sexual violence by either an intimate partner, client or the police. In addition, three variables indicating some or no physical/sexual violence was generated for intimate partners, clients, and police. The number of sexual assaults reported for each perpetrator category in the past year were used continuously. Any past year intimate partner emotion, physical or sexual violence was generated and dichotomised. In addition, items were summed for each perpetrator category with scores >8 indicated some abuse and higher scores indicated increasing levels of abuse.

Finally, all items were used to show past year and lifetime exposure to different types of violence (physical, sexual, and physical/sexual) irrespective of who the perpetrator was.

Other measures of violence included a shortened version of the childhood trauma questionnaire (CTQ) which measured five dimensions: neglect (physical and emotional) and abuse (emotional, physical and sexual) [54]. Twelve questions were asked, including: “I saw or heard by mother beaten by her husband or boyfriend”, “I was insulted or humiliated by someone in my family in front of other people”, and “I had sex with someone who was not my boyfriend because I was threatened or frightened or forced”. Due to a lack of variability, items were scored on a 4-point scale ranging from 1 “never”, 2 “rarely”, 3”many” and 4 “very often”. Items were dichotomised to create a “none/ rarely” and “many/very often”. Items were also summed, with scores >12 indicating some abuse and higher scores indicating increasing levels of abuse. In our study the CTQ yielded a Cronbach alpha of 0.77, suggesting good reliability. Data was also dichotomised to show high levels of emotional and physical abuse, and neglect. An additional question on first sex was added to show some/none sexual abuse: “which of the following statements most closely described your experiences the first time you had sexual intercourse? I was willing, persuaded, tricked, forced, or raped”. For this item, non-consensual sex was defined as being “tricked, forced, or raped” .

Overall, internal and external stigma were measured using an adapted version of the Stigma Index. Questions to measure external stigma included: "Within the past year have you been beaten or threatened because you are a sex worker?" and "Within the past year have you been denied health services because you are a sex worker?", with responses being on a 4-point scale of 1 never to 4 often. Questions to measure internalisation of stigma included: “Within the past year I have felt ashamed because I am a sex worker?”, and “Within the past year I have felt guilty because I am a sex worker?”. Items were scored as “strongly agree” to “strongly disagree”. A variable was generated which indicated that stigma has been experienced and whether it was only internal, external or a

combination of both. A second stigma variable was developed which indicated some or no stigma, but excluded stigma related rape to avoid a duplication of item use between this and polyvictimization.

In assessing other forms of sexual assault, stigma related rape was measured using one question: "Within the past year have you experienced sexual abuse because you are a sex worker?" and gang rape: "have you ever experienced a gang rape?" (rape by multiple perpetrators). Both were scored on a 4-point scale of 1 "never" to 4 "very often" and dichotomised as none versus some. We also asked: "how often has this [gang rape] happened" (continuous). Two additional variables were then generated: any non-intimate partner rape ever reported across the study, which included client, police, stigma, childhood, gang related rapes. The second was all rapes ever reported and included intimate partner rape.

To show the overlap between different forms of violence, and using the afore mentioned variables generated to show some or no violence by a perpetrator category or during childhood, new dummy variables were created which showed whether or not two kinds of violence had been experienced (e.g. childhood and IPV, or childhood and client violence). All possible combinations of violence experienced by perpetrator categories or during childhood were then generated. These were used to create a venn diagram of polyvictimization. In addition, and to show how many types of violence an individual had experienced across their lifetime, a variable was generated to showing incremental increases in exposure to the dichotomised variables showing childhood trauma, IPV, police or client violence.

Coupon numbers were recorded and linked between seeds, recruiters and subsequent recruits. Participants were asked a three-part question to obtain their network size[46]. RDS weighting used for the adjustment was based upon participant's relative network size and recruitment chains. Population-level estimates were developed using crude sample data adjusted to reflect the target

population based upon RDS weights. Socio-demographic characteristic items were used as single items. Questions including: date of birth "what date were you born", home language "what language do you speak" (all eleven official languages were listed as well as other"), and place of birth (All South African provinces were listed, as were countries with whom South Africa shares a border) and highest level of education achieved. Participants were asked about whether or not they were currently dating a male or female partner, the age of their current partner – "how old is your current intimate partner", the number of intimate partners (main partners) which they had had in the past year "how many intimate partners [non paying] have you had in the past year", and whether or not their partner was employed.

4.3.2 STATISTICAL ANALYSIS:

In analysing RDS data, specialised statistical software (Respondent-Driven Sampling Analysis Tool [RDSAT] [55]) was used to assess RDS assumptions including homophily and convergence, and to produce RDS-II population-level estimates[45]. The program is freely available for download along with an operational manual (http://www.respondentdrivensampling.org). Univariate descriptive statistics and violence prevalence were determined (Table 1 & 2). Spearman's correlation was used to develop a covariance matrix of continuous measures for IPV, client violence, police violence and CTQ using only unadjusted data (Table 3). Victimisation and re-victimisation patterns are shown within a modified Venn diagram (figure 1) and a chi^2 test of association between the number of overall violence categories experienced and discrimination (Table 4). Analysis of data was done using RDSAT (adjusted) and STATA13 (unadjusted).

4.4 RESULTS

Table 4-2 showed that the median age of FSWs in Soweto was 31 years, and 71.6% from the Gauteng province. Most had incomplete schooling (74.2%) and 97.1% had a current male intimate partner.

The most commonly reported form of violence was past year IPV, reported amongst 63.3% (emotional), 48.6% (physical), and 20.4% (sexual) of FSWs. The median number of sexual assaults by an intimate partner was three (1-30), with 24.4% of FSWs reporting lifetime exposure to intimate partner rape. Client violence was the second most commonly reported form of violence, with physical and sexual violence in the past year being reported by 42.7% and 13.8%, of FSWs respectively. Any physical or sexual violence by a client in the past year was reported by 46.8% (Table 4-3).

Analysis of violence types by all three perpetrator categories combined (Table 4-4) shows that any physical violence perpetrated by any of the three perpetrators in the past year was 67.6% while any violence ever by a perpetrator was 72.9%. The prevalence of any sexual violence perpetrated by any of the three perpetrators, in the past year, was 30.4%, while 38.0% reported ever experiencing sexual violence by any of the three perpetrators. The prevalence of any violence reported for all 3 perpetrator categories was 79.3% in the past year and 82.3% ever. The childhood trauma questionnaire showed that sexual violence was experienced by 44.3% of FSWs. Both internal and external stigma were reported by 55.2% of FSWs. All non-intimate partner rape ever reported was 55.5%, and overall 62.4% ever reported a rape.

Figure 4-1 shows overlaps in victimization of FSWs in Soweto, with only 14.4% experiencing no childhood, police, client or intimate partner violence across their lifetime. The greatest proportion of overlap is seen between IPV, and client violence and childhood trauma amongst 15.9%, or childhood trauma with 13.0% of FSWs.

Table 4-5 shows that 24.3% experienced only 1 form of violence. Two forms of violence were experienced by 31.0% of FSWs and three of more by 30.0% of FSWs in Soweto. The number of

FSWs experiencing multiple forms of violence per category increased significantly for those who had experienced discrimination as compared with those who had not: 11.3% no violence, 20.5% one exposure, 31.7% two exposures and 36.5% three or more exposures.

4.5 DISCUSSION

Our findings show the disparate vulnerability of FSWs in Soweto to violence by multiple partner categories and across the lifetime of FSWs. We hypothesised that FSWs in Soweto South Africa experience higher levels of intimate partner violence and sexual abuse by any perpetrator than had previously been shown amongst women from the general population. We found that almost 90% of FSWs had experienced some form of violence across their lifetime highlighting their immense vulnerability. Lifetime likelihood of experiencing sexual violence was almost two thirds for FSWs, which is 2.6 times higher than the prevalence reported for women in the general population of Gauteng (62.4% versus 23.5%) [34] and suggests an overwhelming exposure to rape and other forms of sexual violence for FSWs in Soweto. We were correct in our hypothesis that childhood sexual violence exposure would be higher amongst FSWs as compared to the general population in South Africa (44.3% vs 35.4%) [56]. This is consistent with previous findings that childhood sexual assault is higher amongst SWs [39]. Together these findings suggest that engaging in sex work is a key aspect of vulnerability to the high levels of violence in adulthood and denotes the relationship inequalities between FSWs and their partners (both paying and non-paying).

As hypothesised, our findings were similar but with higher levels of reporting exposure to violence by type, as compared to other studies of violence exposure in FSWs. Sexual violence in the preceding year was almost 50% higher than that recorded in the SAHMS (30.4% vs 21.9%). However, this is to be expected given the depth of questioning within our study, which is not included in other studies on violence amongst FSWs. Exposure to IPV was similar to a 2015 study on violence against substance abusing SWs [42]. The unabated continuation of violence into

adulthood resulted in two thirds of FSW experiencing rape and a more than three quarter lifetime exposure to other forms of violence. These findings show the importance of gaining a comprehensive understanding of violence in FSW populations where we have shown substantially higher prevalence overall than previously thought. Given the aggressive masculinities prevalent in South Africa, that FSWs transgress a multitude of social norms, and that sex is paid for, SWs are positioned as a commoditised and dehumanised population. Their relationships with intimate partners, clients and the police are prone to being inequitable, with physical and sexual violence against SWs possibly being perceived by the perpetrators as a "justifiable violence". Thus, there are higher levels of violence amongst FSWs than perpetrated against women from the general population

When we consider violence by perpetrator category, we found that prevalence varied between our and previous research. Exposure to intimate partner physical violence was lower in our study as compared with substance abusing SWs (48.6% vs. 63.3%)[42]. When compared to Kenya [43], our findings were lower (53.8% vs 79%). However, the prevalence of intimate partner rape was consistent with previous research (20.4% vs.19%). Client physical and sexual violence (combined) in the past year was higher in our study than in other studies with almost half of Sowetan FSWs having experienced physical or sexual violence (46.8%) compared with 37% and 20% of street- and brothel-based SWs in Cape Town. Furthermore, and in relation to all forms of violence, we show that there is little variance in exposure to violence by perpetrators for the past year as compared with ever exposed. This highlights the consistent exposure to violence which FSWs are exposed to. These findings, although abhorrent are unsurprising given the aggressive masculinities that SWs can be exposed to. We are concerned that violence perpetration with impunity functions as a driving factor in this epidemic and is possibly magnified in township settings.

Female sex workers are more vulnerable to the co-occurrence of violence than women in the general population. More than 50% of polyvictimization involved IPV, which highlights the vulnerability to

violence by both non-paying and paying partners. That discrimination was strongly associated with the co-occurrence of violence provides important information on the nature of violence against FSWs. This suggest that violence against FSWs is a systematic, work-related discrimination, making it a hate crime. The men who purchase sex are more likely to engage in other violent and criminal activities [26], resulting in an inherent vulnerability for FSWs to violent partners, both clients and intimate. Furthermore, hostilities towards SWs are often grounded in moral ideologies surrounding gender normative behaviours which SWs transgress. Perpetrators of violence against SWs are infrequently held accountable. This is underpinned by a legislative framework criminalising SW in South Africa, which enables unlawful and criminal actions against SWs, by policing officials. Violence by police against SWs in South Africa has been well documented[57-60], and while our study shows lower levels than previous recorded amongst SWs in South Africa, it nonetheless adds to a growing body of evidence highlighting police violence and brutal treatment of SWs.

South Africa is currently in the process of scaling up HIV prevention services for SWs, using the National Sex Worker HIV Plan 2016-2020 as a framework[14]. While these guidelines strongly encourage comprehensive services geared to addressing GBV, it is unclear what this means in terms of interventions in this context. The implementation of a strategy to guard SW rights, while a notable step in the right direction, does require structured programmes to address the prevention of GBV, and address the gender norms underpinning violence against FSWs.

Our study had several limitations. Violence perpetrated by police and gang rape were possibly underreported and may be due to their order in the survey document (asked after client and intimate partner experiences) that could have resulted in participants feeling emotionally overwhelmed and unable to disclose further violence exposure. Other forms of violence were not asked about in this study, including police neglect, and violence by family members and strangers. As such we feel that our findings are an underreporting of violence prevalence. The study focused exclusively on FSWs,

with no clients included. There was some variation between adjusted and unadjusted analysis. Weights were not included in the covariance matrix. Future research is required which aims to understand perpetrator specific patterns of violence and associated factors to ensure that SW program implementers can address areas of concern. Furthermore, research should understand the impact of violence on mental health and on adherence to HIV related medications.

4.6 CONCLUSION AND POLICY RECOMMENDATIONS

The intersection between gender inequality, poverty, violence and HIV [61] creates a public health crisis centring on sexual and physical violence. Sex workers have a heightened vulnerability to violence with the prevalence of polyvictimization confirming that they are positioned on the apex of South Africa's broader violence epidemic. The power differential between FSWs and the men with whom they interact, intensifies their vulnerability. The current legislative framework functions to legitimise violence against SWs through endorsing discrimination and thereby encouraging ideas that there could be "justifiable" or "deserved" violence against SWs. The South African Government needs to take heed of the growing body of knowledge highlighting the vulnerability of this population and begin safeguarding their human rights as part of addressing the overall violence epidemic in South Africa. It is imperative that legislation criminalising SW be reviewed as a fundamental mechanism to addressing violence against SWs. Exposure to such high levels of violence are likely to hamper HIV prevention and treatment interventions targeting FSWs. Thus, there is an urgent need for a programme of research to define what works to prevent violence against SWs from paying and non-paying partners, and clearly define and implement appropriate and inclusive sex work sector violence prevention interventions. Taken together, our findings suggest the normalisation of violence against SWs which requires collective attention by policy makers, programme implementers, researchers and community members.

Table 4-2 Description of demographic characteristics of female sex workers in Soweto, including crude and RDS adjusted percentages with 95% CI.

Variable (n=508)	Overall	
	n (%)	Adj % (95% CI)
Age Median (MED, IQR)	30(18-59)	31(25-37)
Home Language		
Zulu	274(53.9)	52.3(46.0-59.5)
Sotho	131(25.8)	26.7(20.5-32.5)
Other	103(25.8)	21(15.9-26.2)
Place of birth		
Gauteng	346 (68.1)	71.6(64.6-77.2)
KwaZulu Natal (KZN)	86 (16.9)	13.1(9.4-17.9)
Other	76 (15)	15.2(10.5-20.3)
Education		
Incomplete schooling	384(75.6)	74.2(69.2-79.9)
Secondary complete/Some tertiary	124(24.4)	25.8(20.4-30.9)
Number of Intimate Partners (past year) (MED, Range)	1 (0-20)	1.0 (1.0-1.0)
Number of FSW with current male partner	498 (98.0)	97.1(94.2-99.1)
Age of Intimate Partner (MED, Range)	34 (20-62)	34 (28-40)
Employment status of Intimate Partner		
Unemployed	142(27.9)	30.7(25.5-35.8)
Employed	366(71.1)	69.3(64.2-74.5)

Table 4-3 Prevalence and perpetrators of violence, including a summary of overall sexual assault reported, for FSWs in Soweto, including raw and RDS adjusted percentages & CI.

	n(%)	Adjusted % (95% CI)	n(%)	Adjusted % (95% CI)	n(%)	Adjusted % (95% CI)	n(%)	Adjusted % (95% CI)
VIOLENCE BY PERPETRATOR & TYPE								
	INTIMATE PARTNER		CLIENT		POLICE-		-	
Emotional (12 months)	333(65.6)	63.3(57.2-68.2)	-	-	-	-	-	-
Physical (12 months)	268(52.8)	48.6(43.7-54.3)	247(48.6)	42.7(38.1-48.6	38(7.5)	7.2(4.0-10.7)	-	-
Sexual (12 months)	105(20.7)	20.4(16.0-25.1)	74(15.6)	13.8(10.1-17.8	20(3.9)	3.6(1.8-5.5)	-	-
Median Number of Sexual Assaults	3(1-30)	3.0(1.0-5.0)	1(1-7)	1.0(1.0-3.0)	1(1-6)	1.0(1.0-1.5)	-	-
Sexual Ever	124(24.4)	24.4(19.6-29.3)	30(5.9)	5.1(2.9-7.4)	30(5.9)	5.1(2.9-7.4)	-	-
Physical/Sexual Violence (12 months)	288 (56.7)	53.8(48.1-51.9)	265(52.2)	46.8(41.8-53.0	53(10.4)	18.5(14.2-23.7)	-	-
Any intimate partner Violence (12 months)	353(69.5)	67.4(61.3-72.7)	-	-	-	-	-	-
OVERALL VIOLENCE TYPE BY PERPETRATOR: 12 MONTHS & EVER REPORTED								
	PHYSICAL		SEXUAL		PHYSICAL/SEXUAL		OVERALL	
Any by Perpetrators (12 months)	366(72.1)	67.6(62.8-73.2)	161(31.7)	30.4(25.5-35.7	379	70.8(66.2-76.0)	416(81.9)	79.3(74.6-84.1
Any by Perpetrators (Ever)	386(76.0)	72.9(67.8-78.5)	199(39.2)	38.0(32.2-43.4	399	76.0(71.2-81.3)	430(84.7)	82.3(78.2-86.9
CHILDHOOD ABUSE								
	PHYSICAL		SEXUAL		NEGLECT		EMOTION	
Neglect	102 (20.7)	20.8(16.4-25.5)	79(15.6)	14.8(11.1-18.2	93(19.3)	17.2(13.2-22.0)	213 (41.9)	44.3(38.6-50.1
Childhood Abuse Scale (MED, Range)								
EXPOSURE TO STIGMA								
	NO STIGMA		INTERNAL STIGMA		EXTERNAL STIGMA		BOTH	
No stigma experienced	85(16.7)	17.7(13.5-22.5)	75(14.8)	17.1(12.4-21.7	54(10.6)	10.0(7.3-13.7)	294(57.9)	55.2(49.0-60.5
ALL OTHER SEXUAL VIOLENCE	STIGMA RELATED RAPE		GANG RAPED EVER		NON-INTIMATE		ALL RAPE	
Sexual Violence	55(10.8)	8.4(5.7-11.3)	25(4.9)	4.5(2.5-7.1)	277	55.5(50.3-61.3)	314(61.8)	62.4(57.3-68.1
Number of Gang Rapes MED(IQR)	1(1-6)	1.0(1.0-1.0)	-	-	-	-	-	-

Table 4-4 Covariance matrix of violence scores by perpetrator type and CTQ

	50th percentile (Range)	IPV	Client Violence	Police Violence	CTQ
IPV	7(6-24)	1			
Client Violence	7(6-17)	**r_s =0.21, p=<0.001**	1		
Police Violence	6(6-10)	**r_s =0.16, p=0.003**	**r_s =0.24, p=<0.001**	1	
CTQ	18(13-31)	**r_s =0.28, p=<0.001**	**r_s =0.20, p=<0.001**	**r_s =0.17, p=<0.001**	1

Figure 4-1 Victimisation and polyvictimization between IPV, client- and police violence, and childhood exposure to violence (RDS adjusted %).

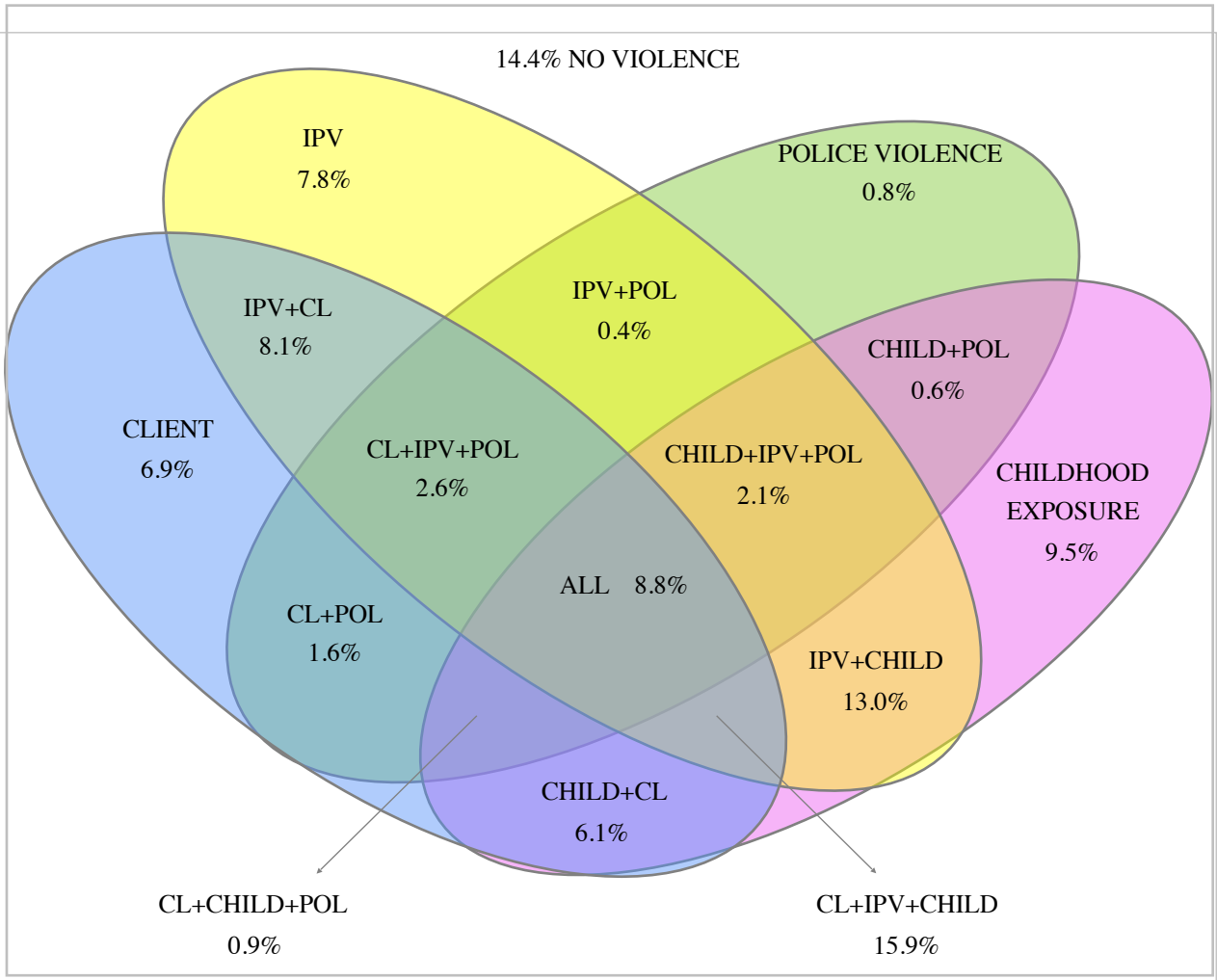

Table 4-5 Polyvictimization across the lifetime of FSWs in Soweto (IPV, client violence, police violence and childhood exposure to violence) by exposure to discrimination (community, familial, police or health official)

	Overall polyvictimization		Some External Discrimination		No External Discrimination	
	N(%)	Adj % (95% CI)	N(%)	Adj % (95% CI)	N(%)	Adj % (95% CI)
No violence	69 (13.6)	14.4(10.3-18.6)	34(9.9)	11.3(6.4-16.6)	35(21.5)	20.5(13.4-27.9)
1 type	117(23.0)	24.3(19.3-29.5)	66(19.1)	20.5(15.2-26.1)	51(31.2)	31.3(21.9-41.8)
2 types	158 (31.1)	31.0(25.4-35.7)	105(30.4)	31.7(24.7-37.5)	53(32.5)	29.8(20.3-39.2)
≥3 types	164(32.3)	30.2(25.5-36.4)	140(40.6)	**36.5(30.4-44.1)**	24(14.4)	**18.5(10.8-28.2)**

5. CHAPTER FIVE: DEPRESSION AND POST TRAUMATIC STRESS AMONGST FEMALE SEX WORKERS IN SOWETO, SOUTH AFRICA: A CROSS SECTIONAL, RESPONDENT DRIVEN SAMPLE

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Table 5-1 Author Contributions Paper Two

AUTHOR	CONTRIBUTIONS
Jenny Coetzee	Conceptualisation, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, resources, software, software, supervision, validation, visualisation, writing – original draft, writing – review & editing
Janice Buckley	Conceptualisation, writing – review & editing
Kennedy Otwombe	Conceptualisation, methodology, formal analysis, writing – review & editing
Glenda E Gray	Conceptualisation, investigation, methodology, supervision, writing – review & editing
Rachel Jewkes	Conceptualisation, investigation, methodology, supervision, writing – review & editing

5.1 ABSTRACT

Background Sex workers in South Africa are exposed to high levels of violence, yet little is known about their mental health needs. This study aims to understanding the prevalence of depression and post-traumatic stress disorder (PTSD) and their risk factors amongst female sex worker (FSWs) in Soweto, South Africa.

Methods A cross-sectional, respondent-driven sampling (RDS) survey enrolled 508 FSWs. Raw and RDS adjusted data were analyzed using a chi-squared test of association and multinomial regression for risk factors associated with depression and PTSD.

Findings Symptoms of severe depression were prevalent amongst 68.7%, PTSD was 39.6%, and 32.7% suffered from comorbid PTSD and depression. Experiencing ≥3 kinds of violence increased the likelihood of comorbidity (RRR4.11, 95% CI 1.52-11.12,p=0.005). Internalised stigma increased the likelihood of one mental health condition (RRR1.25, 95% CI 1.10-1.42,p=0.001), higher self-esteem was associated with independent (RRR1.14, 95% CI 1.05-1.25,p=0.002) and comorbid conditions (RRR1.17, 95% CI 1.07-1.27,p=0.001).

Conclusion Our findings highlight the sizable burden of treatable mental health conditions among FSWs in Soweto. This was driven by multiple exposures to violence, sex work related discrimination and overall moderate levels of self-esteem masking defence mechanisms. This suggests the urgent need to design and integrate services geared to the mental health needs for this population.

Key words:

Sex work, depression, post-traumatic stress disorder, self-esteem, violence, stigma

5.2 INTRODUCTION

Mental health amongst sex workers (SWs) in South Africa has infrequently been studied. This is of importance given their high exposure to violence [1-6] and that sex work in South Africa is criminalized [7,8]. This results in high levels of discrimination, a driver of mental health concerns, being perpetrated against SWs [6]. Yet very few studies address the mental health needs of SWs in South Africa. A 2017 study of SWs attending a support group in KwaZulu Natal, South Africa (n=155), found that 78.4% of their sample suffered from depression and anxiety, while 80% engaged in binge drinking [9]. This study aims to describe the prevalence and severity of both depression and PTSD, and their risk factors amongst FSWs in Soweto, South Africa. We hypothesize that exposure to high levels of violence, and length of time as a sex worker will be strongly associated with both depression and PTSD.

Globally, the mental health of female sex workers (FSWs) has received slightly more attention than in South Africa. A survey in India found depression rates of 39% amongst FSWs (n=1986) [10], and in Nepal they were recorded at 82.4% (n=210) [11]. Studies from both Australia and Israel found rates of between 17% and 31%, for PTSD and 19% and 54% for depression, respectively [12,13]. Research from Switzerland showed that 50.3% of SWs (n=194), suffered from some form of mental health disorder. The same study found that being a migrant SW increased the risk of mental health concerns by almost nine times, while violence increased the risk by three times [14]. A second very small study based in the United States (n=24) found an association between anxiety, depression and self-esteem amongst women who engaged in transactional sex [15].

In sub-Saharan Africa as much as 10% of the disease burden could be attributed to neuropsychiatric disorders, in 2001 [16]. In South Africa, data from a 2002-2004 nationally representative household survey found that adult lifetime prevalence of depression was 9.7%, while past year prevalence was 4.9% [17]. Findings from a study of women in an informal settlement in South Africa showed high

levels of depression amongst young women aged 18-30 years (57.9%) [18]. Research has shown that approximately 16.5% of South Africans suffer from PTSD [19]. A 2008 study in South Africa (n=4351) highlighted the strong association between PTSD and violence. More than one third of females (34.3%) reported violence exposure resulting in a 0.9-3.2 times greater risk of PTSD when compared to non-violence exposed women [20].Furthermore, there are high rates of PTSD and depression amongst female rape survivors (28% and 34% respectively) [20-22].

Globally, exposure to violence is associated with poor mental health [23-26]. Research has also shown the significant association between depression, PTSD and alcohol abuse [27-29]. A second study based in the United States (n=24) found an association between anxiety-depression and self-esteem amongst women who engaged in transactional sex [15]. Furthermore, childhood exposure to violence has also been shown to impact negatively upon adult mental health [28]. Experiences of childhood trauma can cause physiological changes in the brain, potentially impacting upon emotional stability and relationship formation during adulthood, which can lead to further vulnerability to violence [30]. Past year sexual assault is associated with PTSD [29]. Level of depression is also associated with poorer adherence to medication, lower levels of education and being female [17,31,32]. Thus, this study aims to describe the prevalence and severity of both depression and PTSD, and their risk factors amongst FSWs in Soweto, South Africa.

5.3 METHOD

Our cross-sectional study was conducted in Soweto where 508 FSWs were recruited between February and September 2016. The locale is predominantly urban and peri-urban, low-income with limited educational and employment opportunities. It has the highest population density in South Africa: an estimated two million inhabitants within >40 suburbs across 61km^2. Eleven apartheid-era, former single-sex, and ethnically segregated hostels house an estimated 40,000 residents. In 2013, the Perinatal HIV Research Unit (PHRU) began providing HIV services to SWs within the township. Their fixed clinic was used as a base for the research [34]. Formative work included

cognitive interviews (n=12), and a pilot study (n = 40) [2,34]. The full methodology has been extensively described in previous research [2·]

Inclusion criteria for the main study were: biologically female, over 18 years, sold sex in Soweto at the time of the study, knew their recruiter, and gave voluntary informed consent to participate. In determining the sample size, a two-sided calculation was used to detect a 20% difference between HIV prevalence among FSWs who were presumed to be exposed to violence versus those FSWs presumed to be unexposed to violence. A sample size of 500 was estimated to ensure sufficient power of analysis·

A respondent-driven sampling (RDS) recruitment strategy was used [35]. The method is a popular way to recruit marginalized populations for population-level estimates [36,37]. A total of 11 seeds (initial participants) were used during the study. Similar to a chain referral method [36], all participants (including seeds) were given three coupons with which to recruit potential participants. Seeds and subsequently enrolled participants were asked to give the coupons to randomly selected women they knew and who knew them, who, like themselves, sold sex in Soweto, and who were older than 18 years. Recruitment chains were mapped between each seed and all subsequent recruits[37,38].

After screening, participants gave their written consent to participate in the study, and then completed a 45-minute, interviewer-administered questionnaire in English, isiZulu or seSotho. Participants were then given a maximum of three uniquely coded coupons and reimbursed R100·00 (~$7·69, at time of study). A further R20·00 (~$1·56) secondary incentive for successful recruitment was paid 7–10 days later. Primary reimbursement and secondary incentives were increased five months into the study to cover additional costs to participate[2].

Data were captured directly onto Lenovo tablets using the REDCap electronic data management system [39], hosted by the University of the Witwatersrand, South Africa. The database housed built-in skip patterns and algorithms. Duplicate data were collected on a convenience sample of 12% of the final sample size with an error rate of 0·6%. Ethical approval was provided by the Human Research Ethics Committee (Medical) of the University of the Witwatersrand, South Africa·

5.3.1 Measures:

Socio-demographic characteristics were scored as single items. Questions included: date of birth, home language (one of South Africa's 11 official languages or 'other'), and place of birth (South African provinces or countries with a shared national border). Place of birth was used to indicate whether an individual was from Gauteng or a migrant (national/non-national). They were also questioned on their highest level of education achieved (no schooling; primary school incomplete; primary school completed; high school incomplete; high school completed; post school qualification/s, dichotomized into incomplete versus completed post-school qualifications). Previously being pregnant, having had a child die and number of children under 12 years of age were also asked.

Symptoms of depression were assessed using the 20-item CES-D scale [40]. Questions included 'During the past week I was worried by things that usually don't worry me', and 'During the past week I felt I was just as good as other people'. Responses ranged from: 0 'rarely/none of the time', 1 'some of the time (1-2days)', 2 'a moderate amount of time (2-4 days)' and 3 'most of the time (5-7 days)'. Scores were tallied and the scale alpha was 0.84. A cut-off score of 21 was also used to indicate a high level of depression symptoms.

The presence of post-traumatic stress symptoms was assessed using the PTSD-8[41]. Participants were asked 8 questions referring to having 'recurrent thoughts or memories of the event', and 'feeling jumpy, get a fright easily', when they thought about any event which they had found traumatic. The questions were not asked specifically about one traumatic event as this population is

exposed to multiple forms of trauma on an ongoing basis [6]. Evidence has shown the increased risk and severity of PTSD for women exposed to multiple forms of trauma [42]. Responses were scored as 1 'not at all' to 4 'most of the time'. A confirmatory factor analysis was run to confirm the three subscales (hypervigilance, avoidance, intrusion). Scores were tallied for a PTSD scale which showed good Cronbach alpha at 0.89. A second variable was then generated indicating the clinical DSM-IV classification of PTSD (a minimum score of three for each of the three subscales).

To enable a multinomial logistic regression showing depression or PTSD only, comorbid conditions, or no mental health concerns, the mental health variables were each dichotomised. A new categorical variable was then generated which showed depression or PTSD only, comorbid PTSD and depression, and no mental health concerns.

To assess suicidality the question was asked: "In the past year, have you attempted suicide?", and to assess suicide ideation "I want to ask you a question about the past month (four weeks), has the thought of ending your life been in your mind?", and "Within the past year I have felt suicidal because I am a sex worker?". One variable was then generated which indicated no suicidality, ideation only, attempted suicides only, and both ideation and attempted suicide.

Internal stigma were assessed using an adaptation of the People Living with HIV Stigma Index[43] including 8 questions. Internalisation of stigma in the past year was assessed by asking if participants felt ashamed, guilty, blamed themselves, felt unworthy or punished, felt isolated, avoided social gatherings or felt suicidal because of being a SW. Questions were phrased such as: 'Within the past year I have felt ashamed because I am a sex worker?'. Responses ranged from 1 'strongly agree', to 4 'strongly disagree', higher scores indicated more reported internalised stigma. Both exploratory and confirmatory factor analyses were performed to confirm that internal stigma performed as a continuous measured scale. The Cronbach's alpha was 0.70.

Self-esteem was assessed using the 10-item Rosenberg Self-esteem Scale [44]. Items were scored as 3 strongly agree to 0 strongly disagree, with items 2,5,6, and 9 being reverse scored, and included questions such as "At times, I think I am no good at all", and "I feel that I have a number of good qualities". Items were scored providing an overall score (ranged from 0-30), with high scores indicating higher self-esteem. The Cronbach's alpha was 0.73 indicating a strong reliability.

The original AUDIT-C [45] scale was used to show overall binge drinking. This validated scale (Cronbach's alpha: 0.88) has been used in studies on FSWs [1]. Given that within the Soweto context, sex work was taking place within drinking establishments, we felt that it was important to include a question on the average volume per drink: 'How big is a typical drink (one drink, a beer or a glass of wine etc?' Responses reflected the volume of alcohol which had been observed by the local sex work program staff to be consumed in typical FSW venues: "no drinking, 250 mls or less (Small Beer or 1 glass of wine), 440mls, 500mls, 750 mls (Bumpie), 1 Litre, 2 Litres, 5 Litres (Big Box Wine)". A new variable showing severe versus less severe/no binge drinking was created using the 3 original AUDIT-C items and the new volume variable. The creation of this variable has been previously detailed [2]. The new severe binge drinking variable showed good reliability (Cronbach alpha: 0.89). The original AUDIT scale had a cut-off score of 3, a cut-off score of 6 indicate frequent and severe binge drinking on the new scale. While both measures are presented in the tables, only the new severe binge drinking variable is included with any further bi- or multi-variate analyses.

Violence was assessed using the WHO violence against women questionnaire [46] adapted to ask about violence specific to various perpetrator types. This included intimate partner violence (IPV), police violence, and client physical or sexual violence. In assessing physical violence, questions included: "Within the past year did any [partner/client/police] hit you with a fist or with something else (such as a beer bottle, stick or belt) which could hurt you?" and "Within the past year did any [partner/client/police] kick, drag, beat, choke or burn you?". For sexual violence, questions

included: “Within the past year did any [partner/client/police] physically force you to have sex when you did not want to?” and “Within the past year did you have sex with any [partner/client/police] when you did not want to because you were afraid of what he might do?” All forms of violence were assessed by perpetrator category before moving on to the next perpetrator category. Questions were scored on a 4-point scale ranging from 1 “none” to 4 “many”. Three new dummy variables indicating some or no physical/sexual violence was generated for intimate partners, clients, and police were generated.

The childhood trauma questionnaire (CTQ) which measured 5 dimensions: neglect (physical and emotional) and abuse (emotional, physical and sexual) was also included [47]. Twelve questions were asked, including: “I saw or heard by mother beaten by her husband or boyfriend”, and “I had sex with someone who was not my boyfriend because I was threatened or frightened or forced”. Items were scored on a 4-point scale ranging from 1 “never” to 4 “very often”. Items were dichotomised to create a “none/rarely” and “many/very often”. In our study the CTQ yielded a Cronbach alpha of 0·77, suggesting good reliability. Data was also dichotomised to show high levels of emotional and physical abuse, and neglect. An additional question on first sex was added to show some/none sexual abuse: “which of the following statements most closely described your experiences the first time you had sexual intercourse? I was willing, persuaded, tricked, forced, or raped”. For this item, non-consensual sex was defined as being “tricked, forced, or raped” . Finally, a new variable was generated which indicated the co-occurrence of violence in the past year by each perpetrator category and by childhood abuse. This was categories to show exposure to no violence, exposure to one type of violence, to two types of violence or to three or more kinds of violence.

Coupon numbers were recorded and linked between seeds, recruiters and subsequent recruits to use RDS weights for population level estimates. Participants were asked a three-part question to obtain their network size: ‘How many FSWs do you know, who also know you, in Soweto? Of those FSWs, how many are over the age of 18 years? Of these FSWs, how many have you seen over the

past month?' The final response signified participants' network sizes. RDS weighting used for the adjustment was based on participants' relative network size and recruitment chains. Population-level estimates were developed using crude sample data that was adjusted to reflect the target population based upon the RDS-II weight.

5.3.2 Statistical Analysis:

In analyzing RDS data, specialized statistical software (Respondent-Driven Sampling Analysis Tool (RDSAT)[48] and Respondent Driven Sampling Analyst (RDS-Analyst) [49]) were used to assess RDS assumptions critical to ensuring that population level estimated could be generated. These included homophily, and convergence, which have previously been described in detail for this study[50]. As neither package performs statistical testing, interpretation was based upon adjusted 95% confidence intervals (95% CI). Significance was assumed if there was no overlap between 95% CI. Univariate and bivariate descriptive statistics and frequencies were determined for categorical variables presented by mental health condition.

For inclusion within the multivariate model, variables needed to be significant at a bivariate level on interpretation of the 95% CI, or suggested by the literature to be relevant to vulnerability for mental health concerns. Both RDSAT and RDS-Analyst are currently limited in its ability to perform multivariate analysis. Thus, RDS weights were exported using the RDS-II function on RDS-Analyst for the multivariate analysis which was performed in STATA 15. Cluster analyses were performed to confirm no clustering due to recruitment. The analysis presented is a multinomial logistic regression run for both weighted and unweighted data and providing a relative risk ratio (RRR). Final models were recursively developed using backward and forward stepwise elimination in which variables were retained in the final model at $p \geq 0.05$. In addition to the final variables presented in the models, variables considered for inclusion within the models were: level of education, place born, pregnancy, child death, and number of children under 12 years. The final analyses presented for both weighted and unweighted models included only variables which were

then pre-selected based upon the sensitivity analyses. Minor differences existed between the weighted and unweighted models, offering very similar models in explaining factors associated with comorbid depression and PTSD. One observation was dropped across the multivariate analyses due to missing responses.

5.4 RESULTS

In total, 508 FSWs were enrolled into the study over 7 months during 2016. All but two participants were black African, with sixteen cross-border immigrants. Recruitment chains progressed up to a maximum of 25, with 2 seeds being highly productive (10-25 waves), 4 seeds minimally productive (4-8 waves), and 5 non-productive seeds. Equilibrium, homophily and convergence were achieved on all key variables examined, including depression, PTSD, age, education and severe binge drinking (see supplementary information).

As shown in Table 1, the median age of FSWs in Soweto was 31 (IQR: 25-37) years. Almost three quarters were born in Gauteng (71.6%) and had incomplete schooling (74.2%). Almost half (48.2%) slept at home or in non-SW related venues. The remainder slept in flats or abandoned buildings and hostels (24.6%), or SW related venues such as brothels (28.7%). Most had been pregnant in their lifetime (87.9%) with 18.1% reporting the death of a child, and the median number of children under the age of 12 years was 1.2. Almost two thirds reported that they regularly went without food (63.0%). No violence was reported by 14.4% of FSWs. One type of violence was reported by 24.3%, two types of violence by 31.0% of FSWs, and three forms of violence were reported to co-occur amongst 30.2% of FSWs. The standard AUDIT-C recorded that 84.8% of FSWs engaged in problematic drinking while severe binge drinking was found amongst 55.0% of FSWs.

Table 2 showed that the median score for depressive symptoms was 25 (IQR: 19-31), with 68.7% having high depression symptoms. The median PTSD symptom score was 18 (IQR: 10-22). PTSD

diagnostic criteria were met in 39.6% of FSWs. No mental health concerns were found amongst 28.9% of FSWs, while PTSD or depression were seen amongst 38.4% of FSWs and 32.7% had comorbid conditions. The majority of FSWs (85.6%) reported no suicidal ideation or attempts in the past 12 months. Suicidal ideation (but no attempts) were reported by 3.6%, while 9.8% reported ideation and attempts (1% reported attempting suicide but without ideation). The median internalised stigma score was 14 (IQR 13-16), and for self-esteem the median score was 11 (IQR 9-13).

Table 3 shows demographic characteristics and risk factors by depression or PTSD, with no significant differences found between those suffering with a depression versus those not depressed. Amongst those who were depressed, the median age was 30 and 31 years, respectively, most FSWs were from Gauteng (69.0%), and 76.2% had an incomplete high school. Of those who were depressed 23.7% had slept in flats or abandoned buildings, 47.4% with family, and 28.9% in SW related venues over the preceding week. Pregnancy was reported by 89.9% of depressed FSWs, and 20.1% reported the death of a child. The median number of children was 1.2, and 60.1% of depressed women reported regularly going without food. The co-occurrence of violence ranged from no violence exposure (12.9%), experiencing only one form of violence exposure (24.2%), two forms of violence exposures (29.5%), and three or more forms of violence exposures (33.5%). The median internalised stigma score was 14 (IQR 13-16), and 54.0% of those affected by depression engaged in severe binge drinking. Self-esteem median score amongst those who had symptoms of depression was 11 (IQR 9-13).

Similarly, table three also shows little difference between most demographic factors by those suffering from PTSD. The only significant difference was between PTSD groups on other sleeping arrangements in the past week: amongst PTSD affected, 36.9% had slept with family while 36.6% slept in SW related venues, compared with 55.1% who had slept with family or non-sex work related venues. Amongst those with or without PTSD, the median age was 30 (IQR 25-36) years,

70.4% came from Gauteng, and three quarters had incomplete tertiary education (75.6%). Ever having been pregnant was reported by 86.4% of FSWs and 18.2% reported the death of a child, while 1.2 was the median number of children <12 years of age. Regularly going without food was reported by 59.5% of those with PTSD, and 26.4% reported sleeping in a flat or abandoned building. The number of violence co-experiences amongst PTSD affected FSW was none (11.1%), one type (25.8%), two types (29.4%), and three or more types (33.7%). The median internalised stigma score was 14 (IQR 13-16), and severe binge drinking was found amongst 57.6% of those suffering from PTSD. Self-esteem median score was 13 (IQR 8-13) irrespective of whether PTSD was present or not.

Table 4 shows the multinomial logistic regression comparing no mental health concerns, with either depression or PTSD independently or comorbidity. The weighted analysis shows that increasing age of first selling sex increased the likelihood of having one of the two mental health concerns (RRR 1.09, 95% CI 1.04-1.14, p=0.001), while having experienced three or more kinds of violence increased the likelihood of comorbid conditions by four times (RRR 4.11, 95% CI 1.52-11.12, p=0.005). Experiencing three or more kinds of violence also affected the likelihood of an independent condition by 3 times (RRR 3.00, 95% CI 1.22-7.39, p=0.017). The internalisation of stigma increased the likelihood of having an independent mental health condition (RRR 1.25, 95% CI 1.10-1.42, p=0.001), while higher self-esteem affected both conditions independently (RRR1.14, 95% CI 1.05-1.25, p=0.002) and comorbid conditions (RRR 117, 95% CI 107-1.27, p=0.001).

5.5 DISCUSSION

Our findings demonstrate the significant burden of mental illness amongst FSW. Our study adds to a small body of literature in South Africa highlighting the vulnerability of FSWs to mental health conditions, and how neglected this field of study is. Our findings show that more than two thirds of FSWs in Soweto suffer from symptoms suggestive of severe depression, and more than a third suggestive of PTSD. We also highlight the high comorbidity of PTSD in depressed symptoms

amongst FSWs, conditions which have been shown to be comorbid in the general population. That 10% of the population have had either suicidal ideation and attempted suicide is of concern. In addition, we show that almost three quarters of FSWs had internalised feelings of shame and guilt surrounding their engagement in sex work which increased the risk of mental health symptoms. Overall, we found low levels of self-esteem amongst FSWs, but higher self-esteem was associated with more mental health problems. Critically, our study showed the impact of repeated exposures to violence on mental health concerns. Our findings also show the high rates of binge drinking, which is consistent with those previously shown amongst FSWs in South Africa (84.8% versus 80.0%) [1].

Our findings highlight the high prevalence of depression and PTSD amongst FSWs as compared to other populations. This is important given that FSWs are marginalised and often discriminated against because of their line of work [52,53]. Overall there is a far higher vulnerability to mental health concerns within this subset of the population where the prevalence of PTSD were double those of the general South African adult population (39.6% vs 16.5%) [19]. The rates of PTSD in our study were higher than in studies of FSWs in Australia and Israel (31% and 17%, respectively) [12,13]. The prevalence of depression amongst FSWs in Soweto was also higher than those documented in South Africa, with more than two thirds of FSW in Soweto suffering from depression as compared with 4.9% in the total adult population [17]. While the prevalence of depression in our study was slightly lower than that recorded amongst SWs in KwaZulu Natal (66.3% versus 78.4%) [9], we note that the KwaZulu Natal study drew from a subset of SWs who were already attending a support group which may have biased the sample. Our findings are almost 10% higher than those found amongst young women in an informal settlement in South Africa [18]. While being 10-30% higher than those documented amongst FSWs across studies [10 12,13] they are substantially lower than the prevalence of depression found amongst Nepalese SWs [11]. Overall, our findings highlight the need to integrate effective mental health screening and interventions within existing programs which target SWs.

Exposure to violence was most strongly associated with both depression and PTSD. Previous research has shown the vulnerability of FSWs in Soweto to high levels of violence throughout their lifetime[6], and this study confirms the impact which repeat occurrences of trauma is having on the lives of these women. We showed high levels of repeated exposures to violence across the lifetime, which strongly impacts both depression and PTSD as well as their comorbidity. When compared to rape survivors in the general population, the current study shows that PTSD and depression amongst FSWs is extremely high [20,22,54], as is their risk of sexual violence as shown in previous findings from the same population [6]. Previous research has shown far greater levels of poly-victimization and past year exposure to violence amongst FSWs than in the general population [6]. Interestingly, exposure to childhood violence was not directly associated with mental health complications. Previous findings have shown that the relationship between childhood violence and mental health for FSWs in Soweto, is mediated through past year exposure to violence (Coetzee et al 2017). Our findings show the need for strategies to reduce the prevalence of gender based violence (GBV) in South Africa while strengthening psychosocial support services. This will be of importance for FSWs who have limited access to mental health services and are currently the focus of intensive HIV treatment and prevention campaigns. The established link between mental health and adherence to medication [31,32] should serve as strong encouragement for policy makers and implementers alike to ensure that a strong set of preventative interventions to stop violence exposure are implemented alongside comprehensive mental health services.

Our study found a very high rate of internalised stigma and a strong association between the how women saw themselves as sex workers which both complicated and was complicated by their mental health. Such internalised stigma, as previously found, decreases access to health services, thus increasing the risk of health complications [53]. Approaches to healthcare access which are cognizant of the mental health needs of this population, and which are more holistic in nature, may be important to meeting the overall needs of the population. The criminalisation of sex work has been documented to force SWs to conceal their identities [9], and the negative social views on SW

often lead to SWs feeling isolated and to increasing levels of discrimination being enacted by family, community and public protectors such as health and policing officials [6,55,56]. Legislative frameworks and policies which not only contradict South Africa's Constitution, but further the vulnerability of FSWs while stifling their mental health needs, must be revised by the South African Government.

Our study found overall low levels of self-esteem amongst FSWs. While the range of self-esteem scores is from 0 to 30, our median was 11, ranging from 9-13. This suggests that FSWs in Soweto have a low to moderate low self-esteem. Interestingly, we found a strong association between increasing levels of self-esteem, and both depression and PTSD, as shown in the final model. Our findings suggest that while FSWs in Soweto have overall low levels of self-esteem, higher levels of self-esteem may be masking greater levels of psychological distress, measured through depression and PTSD. This suggests that there are possibly psychic coping strategies being employed by FSWs which may present as a slightly higher self-esteem, and mask very severe levels of underlying mental distress. More researcher is needed to understand the complex mental health challenges which FSWs face and psychological responses.

The high levels of overall binge drinking found amongst FSWs [1], and that more than 50% of the population engage in severe and frequent binge drinking, shows that alcohol is plausibly used as a coping mechanism despite its lack of association with either mental health outcome. Further research is required in order to understand the link between mental health concerns and alcohol consumption in this population. Current SW health strategies reflect on the need for substance abuse interventions, yet South Africa has inadequate rehabilitation services for the general population, let alone a key population [56]. Furthermore, it is interesting to note that while factors such as childhood exposure to trauma, pregnancy, and education, are associated with mental ill health in the general population [17,31,32], they were not significantly associated with mental ill health in this population. Thus, highlighting the importance of future studies on mental ill health amongst SWs.

Our study had several limitations including that the CES-D measure did not provide a diagnostic measure of depression, but rather an indication of high levels of depressive symptoms. The same limitation applies to our measure of PTSD. The AUDIT-C short measure is possibly inadequate to assess chronic binge drinking, and despite efforts to improve the measure, results should be interpreted with caution. Future work needs to understand the defence mechanisms underpinning the overall low self-esteem in this sample, and how this is functioning in combination with other mental health concerns. The data were collected cross-sectionally. We did not ask about treatment for mental health concerns.

5.6 CONCLUSIONS AND RECOMMENDATIONS

In South Africa, mental health is a largely neglected public health concern. Our findings highlight the burden of vulnerability for FSWs in Soweto, who are exposed to poor living and working conditions while being afflicted with a serious burden of mental health conditions. There is limited availability of mental health services in South Africa. Thus, the roll-out of sex work programs in South Africa is an opportune point from which to provide some basic screening, counselling, and supportive services. However, the pervasive nature of violence in South Africa, particularly amongst this population, and the lack of political will to address this will make sustaining mental health a challenge. Research is needed which expands on our understanding of mental health in this population, and on mechanisms to treat or prevent mental health conditions within the context of repeat exposures to violence, minimal access to resources, and a highly stigmatised profession. The lack of knowledge on these factors compromises South Africa's ability address mental health, and the scaling up sex work programs.

Table 5-2 Demographic and Risk factors of FSWs in Soweto (including RDS adjusted % and 95% CI).

VARIABLE	OVERALL	
	N(%) or median (IQR)	Adjusted % (95% CI) / median (IQR)
Age	30.7(18-59)	31(25-37)
Born		
Gauteng	346 (68·1)	71·6(64·6-77·2)
Other	162 (31.9)	28.6(22.7-35.5)
Education		
Incomplete schooling	384(75·6)	74·2(69·2-79·9)
Complete Secondary/Some Tertiary	124(24·4)	25·8(20·4-30·9)
Slept in the Past week		
Flat-abandoned building-hostel	144(28.3)	24.6(20.1-30.2)
Family/ not SW related	218(42.9)	48.2(42.1-53.9)
SW house/brothel/hotel	146(28.7)	27.2(22.6-32.2)
Pregnant Ever		
No	439(86.4)	12.1(8.4-15.8)
Yes	69(13.6)	87.9(84.0-91.7)
Child Died		
No	417 (82.1)	81.9(76.9-86.9)
Yes	91(17.9)	18.1(13.8-23.2)
Number of children <12 years average (range)	1.1(0-5)	1.2(1.0-2.0)
Regularly goes without food		
No	182(35.8)	37.0 (31.5-43.1)
Yes	326(64.2)	63.0 (56.8-68.6)
Childhood Trauma	19 (12-34)	18 (16-21)
Exposures to violence		
None	69(13.6)	14.4(10.3-18.6)
1 type	117(23.0)	24.3(19.2-29.9)
2 types	158(31.1)	31.0(25.4-36.0)
≥3 types	164(32.3)	30.2(25.9-36.5)

AUDIT-C		
None/Low	79(18.5)	15.2(11.3-27.5)
High	348(81.5)	84.8(79.5-88.8)
Severe Binge Drinking		
Low/moderate	230(45.3)	45.0(39.1-50.8)
Severe	278(54.7)	55.0(49.5-60.8)

Table 5-3 Mental health concerns amongst FSWs in Soweto

	N(%) or median (IQR)	Adjusted % (95% CI) or median (IQR)
Depression	25 (18-31)	25 (19-31)
Depression (cut point 20/21)	336(66.4)	68.7(63.4-73.6)
None/Lower levels of depressive symptoms	170(33.6)	31.3(26.5-36.5)
PTSD score	18 (8-22)	18(10-22)
PTSD diagnostic criteria met	195 (38.4)	39.6(33.5-45.2)
Comorbidity of PTSD & Depression		
No mental health issues	154 (30.3)	28.9(23.9-34.6)
PTSD or Depression independently	191 (37.6)	38.4(33.2-43.7)
Comorbid PTSD & Depression	163 (32.1)	32.7(27.0-38.3)
Suicidal		
None	453 (87.2)	85.6(80.6-89.9)
Ideations Only	15 (2.9)	3.6(1.5-6.1)
Attempted only	5 (1.0)	1.0(0.02-1.9)
Both ideations & attempted	45(8.9)	9.8(6.3-14.4)
Internalised Stigma	14(8-25)	14(13-16)
Self Esteem	10 (1-17)	11 (9-13)

Table 5-5 Linear regression analysis of factors predicting DEPRESSION and PTSD amongst female sex workers in Soweto

	No Mental Health	Depression or PTSD Individually				Comorbid Depression & PTSD			
		Unweighted		Weighted		Unweighted		Weighted	
	(Base outcome)	RRR (95% CI)	p-value	RRR (95% CI)	p-value	RRR (95% CI)	p-value	RRR (95% CI)	p-value
Age first sold sex	-	1.041(1.004-1.079)	0.027	1.092(1.044-1.141)	0.001	1.0(1.0-1.1)	0.954	1.0(1.0-1.1)	0.253
Co-occurrence of violence									
No violence	-	(ref)	-	(ref)	-	(ref)	-	(ref)	-
1 type	-	1.5(0.7-3.2)	0.265	1.8(0.7-4.1)	0.192	0.9(0.4-2.1)	0.888	1.7(0.6-4.5)	0.322
2 types	-	1.3(0.6-2.7)	0.454	1.7(0.7-4.1)	0.250	1.3(0.6-2.7)	0.519	1.6(0.6-4.4)	0.315
≥3 type	-	2.9(1.3-6.2)	0.008	3.0(1.2-7.4)	0.017	3.6(1.7-7.8)	0.001	4.1(1.5-11.1)	0.005
Internalised Stigma	-	1.14(1.04-1.24)	0.003	1.3(1.1-1.4)	0.001	1.0(0.9-1.1)	0.589	1.1(0.9-1.3)	0.215
Self-esteem	-	1.1(1.1-1.2)	<0.001	1.1(1.1-1.3)	0.002	1.2(1.1-1.3)	<0.001	1.2(1.1-1.3)	0.001

6. CHAPTER SIX : CROSS-SECTIONAL STUDY OF FEMALE SEX WORKERS IN SOWETO, SOUTH AFRICA: FACTORS ASSOCIATED WITH HIV INFECTION

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Table 6-1 Author Contributions Paper Three

AUTHOR	CONTRIBUTIONS
Jenny Coetzee	Conceptualisation, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, resources, software, software, supervision, validation, visualisation, writing – original draft, writing – review & editing
Rachel Jewkes	Conceptualisation, investigation, methodology, supervision, writing – review & editing
Glenda E Gray	Conceptualisation, investigation, methodology, supervision, writing – review & editing

6.1. ABSTRACT

Introduction In South Africa, the rate of HIV in the sex worker (SW) population is exceedingly high, but critical gaps exist in our understanding of SWs and the factors that make them vulnerable to HIV. This study aimed to estimate HIV prevalence among female sex workers (FSWs) in Soweto, South Africa, and to describe their sexual behaviour and other factors associated with HIV infection.

Methods A cross-sectional, respondent-driven sampling (RDS) recruitment methodology was used to enrol 508 FSWs based in Soweto. Data were collected using a survey instrument, followed by two HIV rapid tests. Raw and RDS adjusted data were analysed using a chi-squared test of association and multivariate logistic regression to show factors associated with HIV infection.

Findings HIV prevalence among FSWs was 53.6% (95% CI 47.5–59.9). FSWs were almost exclusively based in taverns (85.6%) and hostels (52.0%). Less than a quarter (24.4%) were under 25 years of age. Non-partner violence was reported by 55.5%, 59.6% of whom were HIV-infected. Advancing age, incomplete secondary schooling, migrancy and multiple clients increased the likelihood of HIV acquisition: >30 years of age was associated with a 4.9 times (95% CI 2.6–9.3) increased likelihood of HIV; incomplete secondary schooling almost tripled the likelihood (AOR 2.8, 95% CI 1.6–5.0); being born outside of the Gauteng province increased the likelihood of HIV 2.3 times (95% CI 1.3–4.0); and having more than five clients per day almost doubled the likelihood (AOR 1.9, 95% CI 1.1–3.2).

Conclusion Our findings highlight the extreme vulnerability of FSWs to HIV. Advancing age, limited education and multiple clients were risk factors associated with HIV, strongly driven by a combination of structural, biological and behavioural determinants. Evidence suggests that interventions need to be carefully tailored to the varying profiles of SW populations across South Africa. Soweto could be considered a microcosm of South Africa in terms of the epidemic of violence and HIV experienced by the SW population, which is influenced by factors often beyond an

the individual level of control. While describing a hitherto largely undocumented population of FSWs, our findings confirm the urgent need to scale up innovative HIV prevention and treatment programs for this population.

6.2. INTRODUCTION

Globally, sex workers (SWs) bear a disproportionately high HIV burden [4]. Despite South Africa entering its fourth decade of the HIV epidemic, much remains unclear about the key structural drivers of the HIV epidemic among female sex workers (FSWs) [4, 60]. Defined as adult individuals who consent to sexual exchange with the primary purpose of monetary benefit [59], sex work remains criminalised in South Africa [70]. Recent studies suggest HIV prevalence of between 40% and 88.4% among this population in South Africa [16, 18, 61]. A 2013 South African Health Monitoring Survey (SAHMS) found HIV prevalence among FSWs in Johannesburg to be 71.8% [16]. In contrast, a 2012 meta-analysis revealed HIV prevalence of 11.8% (95% CI 11.6–12.0) among FSWs from 50 countries, with a pooled prevalence of 36.9% (95% CI 36.2–37.5) across sub-Saharan Africa [60]. This underscores the burden of HIV in this region, with South African FSWs demonstrating extreme vulnerability to HIV. The rate of infection among FSWs in South Africa is also significantly higher than in the general population, where prevalence was 12.2% in 2012, peaking at 25.2% in those aged 25–49 years [267].

Sex work in South Africa has been described as functioning within formal settings such as brothels and hotels, or more informally on street-based hotspots [11, 126, 268]. Limited information is available on sex work within township settings, a prominent feature of South Africa's urban and peri-urban landscape. Evidence suggests that within South African townships, transactional sex provides income for many women of low socio-economic status, but such transactions frequently take place within an existing relationship [30]. A 2002 study described transactional sex-for-money exchanges taking place in Soweto, confirming that such exchanges were informal and ambiguous in comparison

to commercial sex work. The study highlighted that these exchanges served largely as a means of survival for some women [10]. A 2004 study conducted among antenatal women demonstrated the relationship between transactional sex and HIV acquisition, with 21% of female patients in an antenatal clinic in Soweto reported to be engaging in transactional sex, increasing the risk of HIV 1.54 times (95% CI 1.07–2.21) when compared to women with no reported transactional sex relationships [26] . Further research is required to comprehensively describe the informal SW population in Soweto where sexual services are sold to both regular and once-off clients.

Low levels of education, unemployment, gender inequality, violence, migration and poverty are all structural drivers of South Africa's heterosexual HIV epidemic [4, 63, 134, 267]. Together, these factors may also be important structural drivers of entry into the sex work profession [65-68]. A combination of the criminalisation of the profession [4] and exposure to high levels of violence exacerbates FSWs' vulnerability to HIV [69]. The prevalence of violence among FSWs is high, with 50.9% reporting physical assault and 21.9% reporting sexual assault or rape over a 12-month period, in Johannesburg, South Africa. The same study found that that 31.5% of Johannesburg-based FSWs were foreign migrants, with an HIV prevalence of 86.6% as compared with 66.0% among South African FSWs [16].

Within the general population, behavioural factors include inconsistent condom use [34, 53], early sexual debut and age disparity between partners. Sexually transmitted infections (STIs) also increase vulnerability [54-57, 267]. In the general population, age is a significant risk factor, with young women and girls bearing the greatest burden of HIV [62]. Age may also play an important role in SW vulnerability, with evidence that a third of FSWs in Johannesburg were aged 16–24 years (36.5%). Of these, 59.1% were HIV-positive [16]. While early sexual debut, and substance abuse are thought to be associated with entry into sex work [65-68], risky sexual behaviours have been cited frequently as one of the primary drivers of HIV prevalence among FSWs [63, 70-72]. These include

multiple partners (both clients and intimate partners (IP)) and result in increasing exposure to wider sexual networks [267] and substance abuse [9, 16]. Evidence has shown that as many as 81.5% of FSWs in Johannesburg, South Africa engage in binge drinking [16]. Alcohol has been associated with both HIV and unsafe sexual practices [69]. Various sexual practices, including limited or inconsistent condom use [73, 74] and unprotected anal sex [75], increase vulnerability. Unprotected anal sex increases HIV infection by between 1.4 [82] and 5.1 [80] times, with as many as 40% of FSWs along a South African trucking route reporting engaging in anal sex [75]. Dry sex or douching practices, which include inserting various drying or astringent agents into the vagina, can lead to lesions, ulceration and altered pH-levels. These factors increase vulnerability to STIs and possibly HIV[72, 76-78].

An understanding of such micro- through macro-level factors is crucial to the effective development of HIV prevention and treatment programs for this key population. It is, furthermore, vital to understand specific contextual dynamics and the profile of the local sub-population for effective program tailoring. However, limited data is available on areas where sex work was not traditionally believed to exist, such as in township settings.

South Africa is currently in the process of scaling up the *South African National SW HIV Plan 2016–2020,* which has secured commitments for significant funding [59]. Between 1998 and 2016, programs were geared towards reducing SW vulnerability to HIV by focusing heavily on basic peer education, condom negotiation and HIV testing. To ensure that SW HIV programs are designed effectively to minimise risk and maximise impact, it is vital that more knowledge is generated on HIV prevalence and associated risk factors for HIV vulnerability. This is especially important in settings where sex work has been uncovered. Our study aims to estimate HIV prevalence among FSWs within Soweto, and to further describe sexual risk factors and their association with HIV vulnerability in this population.

6.3. METHOD

This cross-sectional study formed part of a larger project aimed at understanding the complex interplay of factors associated with HIV infection for FSWs in Soweto. The study drew on an ecological model [229] of HIV risk whereby SWs may have been made vulnerable to HIV owing to individual factors (e.g. age or level of education), factors pertaining to their relationship with their IP (e.g. condom use), factors relating to their work (e.g. number of clients) and community/societal factors (e.g. policing or laws related to sex work). For this analysis, we focused on factors measured at the individual level, but which reflect on all levels.

The study was conducted in Soweto, a township on the outskirts of Johannesburg, South Africa. Soweto is predominantly urban and peri-urban, low-income with limited educational and employment opportunities. It has the highest population density in South Africa, comprises more than 40 suburbs within 61 km^2, and is estimated to house over two million inhabitants. Soweto has approximately 3 000 drinking establishments (legal and illegal), with R50 million (USD 3.8 million) spent annually on beer. Eleven apartheid-era, formerly single-sex, ethnically segregated hostels house an estimated 40 000 residents. Hostels have a highly politicised and violent history, with hostel dwellers never becoming fully integrated into suburban, township life [42]. Despite encouraging family units to move into the hostels post-apartheid, hostels have remained a source of unrest and crime owing to serious overcrowding, poverty and South Africa's complex socio-political history. These hostels comprise a highly patriarchal environment, valuing an African culture of hegemonic masculinity aimed at the subordination of women [43] and silence surrounding sexuality [12], giving rise to high levels of violence [12, 33]. It is from within these hostel and tavern environments in Soweto that sex work takes place.

A sex work program launched in October 2013 by a Soweto-based research organisation was built on a peer education model and embraced community participation. It provides outreach services, human

rights knowledge dissemination, psychosocial counselling, condom distribution, HIV testing, twice-monthly risk reduction workshops, and connections to care networks. In June 2016, the program launched a primary healthcare service which included the provision of pre-exposure prophylaxis (PrEP) for HIV-negative SWs. Their fixed clinic was used as a base for the research, with interviews conducted in private counselling rooms [232].

FSWs and local SW activist organisations were actively engaged throughout the study design and development phases, through various formal and informal discussion platforms. Sex work peer educators (n = 10) were identified through the local sex work program and trained in basic lay counselling, trauma containment and debriefing, good clinical practice, research data collection, and study-specific training, totalling 5,000 hours between 2014 and 2015. These counsellors were used within both the pilot [232] and main study to conduct screening, enrolment, survey interviews, HIV counselling and testing, and to oversee study recruitment.

Formative work included cognitive interviews with 12 conveniently sampled FSWs, to ensure that the survey instrument was understandable and appropriate. This was followed by a pilot study (n = 40) of study procedures (October–November 2015) [232]. Participants within both formative components met the same inclusion criteria as the primary study, except that FSWs who did not work in Soweto were specifically targeted to participate in interviews (n = 12) and the pilot study (n = 28). Two participants who took part in the formative work were eligible for enrolment in the primary study (n = 2).

During screening, SW status was identified using three mechanisms: 1) screening by a well-trained sex work counsellor; 2) primary screening which asked about engagement in sex work in Soweto; and 3) secondary screening for persons suspected of not being a SW, using local, SW-specific discourses to probe more deeply into the individual's involvement in sex work. Inclusion criteria for the study were: biologically female, over 18 years old, currently sold sex in Soweto, knew their

recruiter, and gave voluntary informed consent to participate in both the survey and HIV testing. While engaging in sex work was a requirement, self-identification as a SW was not required. To avoid duplicate enrolment, fingerprints (left, index finger) were scanned and an algorithm recorded and compared for every enrolment using the FingerTec OFIS system (http://www.fingertec.com/images/brochure/Ofis-E.pdf).

A respondent-driven sampling (RDS) recruitment strategy was used in line with the guidelines provided by the World Health Organisation [252]. This method is a popular way to recruit marginalised populations and enable population-level estimates [236, 237]. The method is geared towards overcoming sampling bias and allowing for the generalisability of findings through data weighting based on participant network size. RDS allows for estimating the proportion of the population by adapting sampling according to the realised network of the given population. This ensures a non-zero probability of inclusion in the sample and allows for the provision of asymptomatically unbiased estimates of the factors associated with HIV infection among FSWs. Much like a random sample, RDS allows for generalisability of findings. RDS assumptions were monitored using specialist software (RDS-Analyst) during data collection, to ensure that all assumptions were met and findings would be generalisable. Reciprocal relationships between recruiter and recruit, or reciprocity, were assumed based upon potential participants' confirmation of an existing relationship between themselves and their recruiter. Homophily, or purposefully recruiting individuals with similar characteristics, was assessed using the ratio of recruits to recruiters who had a corresponding characteristic (e.g. HIV status). This served to ensure that the number of homophilous pairs was close to the equivalent in the sample population of what would be expected to occur by chance. Finally, convergence or equilibrium across the sample was assessed. This indicates that the final sample was not biased by the purposive selection of the initial recruits and, thus, potential bias of all subsequent recruits [234].

In determining sample size, a two-sided calculation was used to detect a difference between HIV prevalence among FSWs presumed to be exposed to violence versus those unexposed to violence. A sample size of 500 was estimated to ensure sufficient power of analysis. Recruitment was undertaken between February and September 2016 (n = 508). Initial participants (seeds) were identified by fellow FSWs as being well networked within the local FSW community, during workshop sessions held monthly in the local sex work program. All seeds were required to have a minimum network of 15 other FSWs that they knew and had seen within the preceding two weeks. They were diverse in age (21–38 years), and worked across different suburbs within Soweto. Four seeds were recruited at the start of the study. Due to several consecutive public holidays in South Africa, recruitment slowed substantially in weeks 7–11, and a further seven seeds were located using existing participants and sex work counsellors/peer educators from geographic areas not yet reached by the sex work program. They were introduced into the study between weeks 13 and 15. This had the advantage of increased diversity among the seed sample and allowed for seeds to be selected who had not been part of the local sex work program. Similar to a chain referral method [253], all participants (including seeds) were given three coupons with which to recruit potential participants. Seeds were asked to recruit FSWs they knew, of varying ages and from multiple sites across Soweto. Potential participants then presented at the site, and once screened and if enrolled, formed the first wave of the study. Once data collection was completed, they were given three coupons with which to recruit future potential participants. Thus, each set of coupons led to subsequent waves of recruitment. All non-seed recruiters were asked to give the coupons only to randomly selected women they knew and who knew them, who, like themselves, sold sex in Soweto, and who were older than 18. Recruitment chains were mapped between each seed and all subsequent recruitments [236, 237] (Fig 6-1). To stop enrolment, no further coupons were distributed after the 498th enrolment.

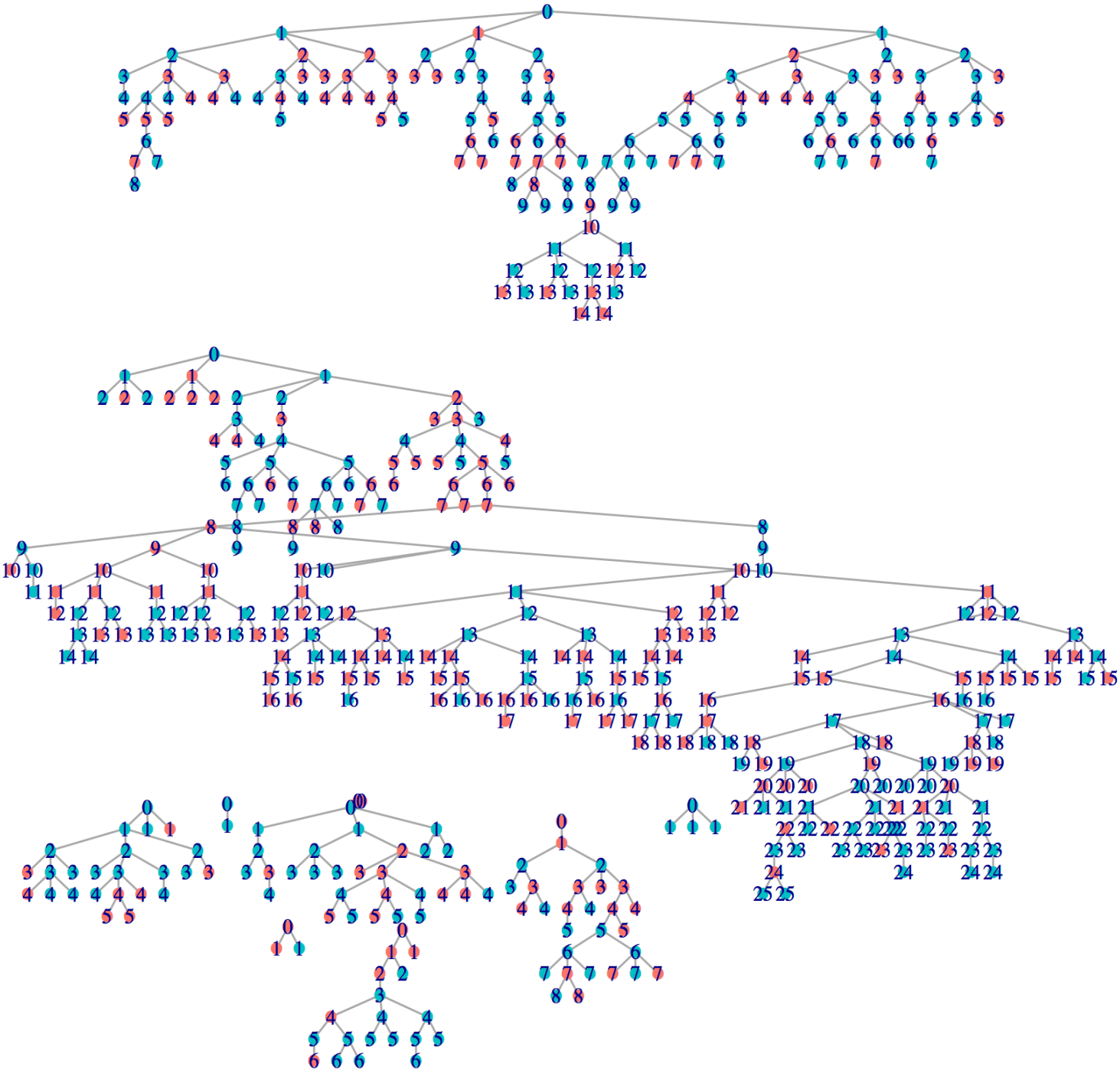

Figure 6-1 Recruitment tree indicating initial seeds recruited (0) and all their subsequent recruits, known as recruitment chains. Waves of recruitment are shown numerically radiating out from each seed (1–25). An HIV-positive status is highlighted in blue.

After screening, participants gave their consent to participate in the study, and then completed a 45-minute, interviewer-administered questionnaire in English, Zulu or seSotho. This was followed by HIV testing and counselling with two HIV rapid tests. After data collection, participants were given a maximum of three uniquely coded coupons and reimbursed R100.00 ($7.69). A further R20.00 ($1.56) secondary incentive for every one of their coupons that led to a successful enrolment was paid 7–10 days after the recruiters' enrolment date. Primary reimbursement and secondary incentives were increased five months into the study to cover additional costs to participate, by a maximum of R20.00 each ($1.56), owing to more widespread geographic recruitment and increased cost of transportation.

Data were captured directly onto Lenovo tablets using the REDCap electronic data management system [254], hosted by the University of the Witwatersrand, South Africa. The database housed built-in skip patterns and algorithms, highlighting missing values before an interviewer could move to the next survey section. Data could be viewed live on the REDCap database to ensure that queries were addressed swiftly before participants left the study site. The system also enabled interviewers to insert detailed comments or explanations on responses they wished to discuss. A 48-hour response-time for checking questionnaires and closing queries was applied during the study. This helped to ensure high quality data were captured consistently. Duplicate data were collected on a convenience sample of 12% of the final sample size with an error rate of 0.6%. Ethical approval was provided by the Human Research Ethics Committee (Medical) of the University of the Witwatersrand, South Africa.

6.3.1 MEASURES

Coupon numbers were recorded and linked between seeds, recruiters and subsequent recruits (Fig 1). Participants were asked a three-part question to obtain their network size: "How many FSWs do you know, who also know you, in Soweto? Of those FSWs, how many are over the age of 18 years? Of

these FSWs, how many have you seen over the past month?" The final response signified participants' network sizes. RDS weighting used for the adjustment was based on participants' relative network size and recruitment chains. Population-level estimates were developed using crude sample data that was adjusted to reflect the target population based upon the RDS weights.

Socio-demographic characteristics were scored as single items. Questions included: date of birth, home language (one of South Africa's 11 official languages or 'other'), and place of birth (South African provinces or countries with a shared national border). Place of birth was used to indicate whether an individual was from Gauteng or a migrant (national/non-national). They were also questioned on their highest level of education achieved (0 – no schooling; 1 – primary school incomplete; 2 – primary school completed; 3 – high school incomplete; 4 – high school completed; 5 – post school qualification/s, dichotomised into incomplete versus completed post-school qualifications). Participants were also asked about the number of children that they had, categorised as no children, one child, two children, or ≥3 children.

Sexual risk behaviour items were scored as single items, and questions included: "How old were you when you first had sex?" (categorised to show legal age of consent), and "For how many years have you been a sex worker?" (categorised as a minimal (1–2 years), moderate (3–7 years) or long (≥8 years) period selling sex). "Does your partner know that you sell sex?" was also asked with a yes/no response set. Questions aimed at estimating the earning potential per sex act in the past day were: "How many of your [regular/one-time clients did you have sex with in the past working day?", and "How much did you earn the last day that you sold sex?" The amount of money earned was divided by the number of clients seen, and dichotomised at R50.00 earned per sex act.

Condom use was assessed by asking whether they had experienced any of the following during the most recent working day: "condom breaking/bursting", "condom slipping off", "condom put on only halfway", "condom removed during sex" and "no problems, condom worked perfectly". Additional

condom-related questions included: “Has there been any occasion in the past month when either a regular or a one-time client went without a condom for any reason when you were having sex?” The response set was ‘yes’, ‘no’ or ‘refuse to answer’. Refuse to answer (n = 2) was assumed to indicate that some inconsistent condom use had existed and the variable was dichotomised into a yes/no. Other questions included: “Over the past year, how often have you experienced the condom breaking or slipping off or only put on halfway, or have you taken it off and continued have sex?” (1 – every time; 2 – often; 3 – sometimes; 4 – never; 5 – condom never used); and “The last time you had sex with a [onetime / regular client, did you use a condom?” (0 – without condom; 1 – male condom; 2 – female condom; 3 – male & female condoms). All condom variables were used to create one variable which reflected any inconsistencies in either condom use or in response sets across the multiple condom variables. This was not a scale, but rather an indication of correctness and consistency of use and responses.

Participants were also asked about sex work-related practices: “In the past month, have you used anything to dry/clean/tighten your vagina before having sex?”; “In the past month, have you used anything to lubricate your vagina during sex?”; and “In the past month have you used anything to hide that you were bleeding/menstruating while having sex?” Response options ranged from 1 (every time) to 4 (never). Participants were given a checklist of items to indicate which they had used for dry sex or to hide menstrual bleeding. Pick-up location was determined by asking: “Where do you normally pick up your clients?” and a checklist of 19 possible pick-up locations was provided, including venues such as brothels, hotels, streets, truck stops, hostels and taverns. Questions were drawn, in part, from an existing sex work surveillance questionnaire [16], the WHO sexual and reproductive health questionnaire [269], but were also based on programmatic evidence indicating the use of specific practices by the community.

AUDIT-C [260] was used to assess binge drinking. This validated scale ($\propto$ 0.891) has been used in studies on FSWs [16]. An additional question to assess the average volume per drink was added: "How big is a typical drink (one drink is a beer/glass of wine, etc.)?" The research team felt that this was important given that the original audit scale did not consider the volume of each drink, and that such large quantities of alcohol are consumed in Sowetan taverns and hostels. In South Africa, for example, a 750ml beer is considered one drink and is typically sold within taverns and hostels in Soweto. This is three times the volume of a standard beer (250 ml). Responses were, thus, based upon standard drink volumes sold in local drinking establishments as single drinks (0 – no drink; 1 – 250 ml (small beer or glass of wine); 2 – 440 ml; 3 – 500 ml; 4 – 750 ml (bumpie); 5 – 1-litre wine, 6 – 2-litre wine, 7 – a 5-litre (big box wine)). The volume variable was converted into millilitres.

A new drinking variable was created using the AUDIT-C scale, with the additional volume variable included. The original audit scale scores were calculated using the three-item scale with the standard female cut-off at 3. A chi-square test of association was conducted between the audit categories and the volume of alcohol consumed per drink, showing a significant association. A new four-item audit score was then developed which included the volume variable (millilitres consumed). To test this item, we divided our dataset in half and ran an exploratory factor analysis on the first half of the dataset, yielding loadings on one factor. A confirmatory factor analysis on the second half of the data confirmed these loadings, accounting for covariates. A final confirmatory factor analysis was run on the entire dataset. The Cronbach alpha score for our dataset was 0.89 on the new scale as compared with 0.78 using the original scale. This suggested the new scale's acceptability for use in this study. A cut-off score was determined by considering contextual factors relating to sex work in Soweto and allowing for a realistic estimate of the volume of alcohol that could be consumed infrequently. A score of 6 enabled a person to drink 500 ml of alcohol infrequently. The final scores were dichotomised, with any score $\geq$6 indicating a high level of binge drinking.

In assessing STI symptoms, participants were asked: “In the past 6 months, have you experienced any of the following symptoms: painful or burning urination; sores/boils around vagina; itching vagina; abnormal vaginal discharge; pain in bottom of stomach unrelated to menstruating/loop; or none of the above?” This was dichotomised as symptoms present versus symptoms absent.

Violence was assessed using the WHO violence against women questionnaire [261], which was adapted to ask about violence specific to various perpetrator types, including IPs. In assessing physical violence, questions included: “Within the past year, did any [partner/client/police hit you with a fist or with something else (such as a beer bottle, stick or belt) which could hurt you?”, and “Within the past year, did any [partner/client/police kick, drag, beat, choke or burn you?” Questions around sexual violence included: “Within the past year, did any [partner/client/police physically force you to have sex when you did not want to?”, and “Within the past year did you have sex with any [partner/client/police when you did not want to because you were afraid of what he might do?” All forms of violence were assessed by perpetrator type before moving onto the next perpetrator type. Questions were scored as 1 – never; 2 – once; 3 – a few times; and 4 – many times.

The following question was drawn from the Childhood Trauma Questionnaire (CTQ): “I had sex with someone who was not my boyfriend because I was threatened or frightened or forced”, with responses ranging from 1 (never) to 4 (very often). Questions also included stigma-related rape: “Within the past year have you experienced sexual abuse because you are a sex worker?” (1 – never to 4 – very often), and forced first sex: “Which of the following statements most closely describes your experiences the first time you had sexual intercourse?” Response choices were: 1 – I was willing|; 2 – I was persuaded; 3 – I was tricked; 4 – I was forced; and 5 – I was raped. A new variable was created with options 3–5 being categorised as sexual assault versus no sexual assault (1–2). All violence questions were dichotomised into no violence versus some violence. For the analysis, two violence variables were generated: IP physical/sexual assault, and a non-IP sexual assault. The

original WHO violence against women questions relating to intimate partners were then used to generate a variable indicating some or no physical/sexual violence by an IP. All other violence questions were used to generate the second violence variable relating to any other sexual violence reported during the study, which included client or police sexual assault, childhood sexual assault, stigma-related rape or forced first intercourse.

In line with WHO Guidelines [238], two rapid assays were conducted to ascertain HIV status (Abon™ and First Response™). An enzyme-linked immunosorbent assay (ELISA) was used on individuals who tested indeterminate (n = 2).

6.3.2 STATISTICAL ANALYSIS

In analysing RDS data, specialised statistical software (Respondent-Driven Sampling Analysis Tool (RDSAT)[263] was used to assess homophily, convergence, and to produce population-level estimates. The program is freely available for download, along with an operational manual (http://www.respondentdrivensampling.org). As RDSAT does not perform statistical testing, interpretation was based upon adjusted 95% confidence intervals (95% CI). Significance was assumed if there was no overlap between 95% CI. Univariate and bivariate descriptive statistics and frequencies were determined for categorical variables presented by HIV infection (Table 6-2 & 6-3). Female SW behaviours are presented in Table 6-4 (univariate only). A chi-square test of association was used for bivariate analysis on both adjusted (RDSAT) and unadjusted data (STATA13).

For inclusion within the multivariate model, variables needed to be significant at a bivariate level on interpretation of the 95% CI, or suggested by the literature to be relevant to SW HIV vulnerability. RDSAT is currently limited in its ability to perform multivariate analysis. A second package, Respondent-Driven Sampling Analyst (RDS-Analyst) [242] was used to export equivalent RDS weights using the RDS-II function for the multivariate analysis which was performed in STATA13. Extensive sensitivity analyses were conducted at a multivariate level using mixed effects logistic

regression models to control for potential clustering, which may have resulted from RDS recruitment. This was done using the svyset command. Originating seed, wave of recruitment and residential suburb were specified as random effects, and no severe clustering effects were found. Therefore, the logit command was used to perform the multivariate analysis (weighted and unweighted). Multiple logistic models were developed for both adjusted and unadjusted factors associated with HIV seropositive status. Both forward and backward stepwise elimination were used manually to develop the final models (Table 6-5), in which variables were retained at $p = \geq 0.5$. In addition to the final variables presented in the models, variables considered for inclusion within the models included consistent and correct condom use, dry sex, duration of involvement in sex work, IP condom use, pick-up venue, binge drinking, IP violence and any sexual violence by a non-IP. Minor differences existed between models. Five observations were dropped from the multivariate analyses due to missing responses relating to a partner knowing that sex was being sold. This was the only missing data.

6.4. RESULTS

In total, 508 FSWs were enrolled in the study over seven months during 2016. All but two participants were black African, with 16 cross-border immigrants. Recruitment chains progressed up to a maximum of 25, with two seeds highly productive (10–25 waves), four seeds minimally productive (4–8 waves), and five non-productive seeds (Fig 6-1). Equilibrium, homophily and convergence were achieved on all key variables examined, including HIV status, age, education and drinking.

Participants ranged in age from 18–59 years, with 24.4% 18–24 years of age, 20.9% 25–29 years, and 55.6% 30 years or older. Slightly more than half were Zulu speaking (52.3%) and 71.6% originated from the Gauteng province, where Soweto is located. Only 25.8% had completed their secondary schooling or done some tertiary level schooling. A small proportion of FSWs did not have

any children (13.2%), while 32.2% had one child, 33.5% had two children and 21.1% had ≥3 children. HIV infection was prevalent in 28.8% of those aged 18–24 years, as compared with 48.7% among 25–29 year olds, and 65.6% among those 30 years and older. There was no difference in HIV prevalence between different home languages. Of the FSWs that came from outside Gauteng, 70.6% were HIV-positive, as compared with 46.9% from Gauteng. More than half of those with an incomplete education were HIV-infected (60.1%). Of FSWs who had three children or more, 64.3% were HIV-positive (Table 6-2).

Most reported their first sexual experience between the ages of 16 and 25 (69.1%). Thirty-eight percent reported selling sex for ≤2 years, 41.4% for 3–7 years and 20.1% for ≥8 years. Only one in five FSWs had told their primary partner that they sold sex (19.9%). The number of clients in the previous working day ranged from 0–19, with 56.6% reporting sex sold to 5–19 clients. Almost three quarters (70.4%) earned ≤ R50.00 (≤ $4.00) per client on their last working day. Correct and consistent condom use was reported 22.3% of the time. Dry sex practices were reported by one in four women (24.9%). Almost half the FSWs had reported STI symptoms in the past six-months (49.8%), and 52.2% used a hostel as a pick-up location. High levels of binge drinking were reported in 76.2% of the respondents. Intimate partner violence was reported at 53.8%, while sexual violence by a non-IP was reported at 55.5%. Age at first sex was not significantly associated with HIV status. Most FSWs who had told their partner that they sold sex were HIV-infected (74.2%). Almost 60% of sex workers who had more than five clients per day were HIV-positive. Neither earning potential per client nor condom use differed according to HIV status. However, 67.7% of those reporting dry sex and 61.2% of those reporting STI symptoms were HIV-positive. Selling sex in a hostel was not significantly associated with HIV, and HIV was not more common among women with high levels of binge drinking, nor among those exposed to IP violence. However, 59.6% of women who reported non-IP sexual assault were HIV-positive (Table 6-3).

Reasons for sex work included: supplementing family income (39.4%), no income for food/shelter, or having been kicked out of their homes (28.6%). Sex was usually sold within taverns and hostels (85.6% and 52.0%, respectively) with less than 20% reporting selling sex in a brothel, hotel or on the street. Vaginal sex was the most popular service procured by clients (89.5%). Overall, anal sex was sold by 22.0% of FSWs and 70.7% of those engaging in anal sex reported consistent condom use by clients (not shown in table). Lubricant use was reported by 47.3%, with actual lubricant the most popular agent (43.2%). Hiding menstrual bleeding was practiced by 32.1% of FSWs (Table 6-4).

As shown in Table 6-5, for the adjusted analysis, age was significantly associated with HIV infection, with those aged 26–30, and >31 having a 2.9 and 4.9 times greater likelihood of being HIV-infected, respectively (95% CI 1.3–6.3, p = 0.008, and 95% CI 2.6–9.3, p = 0.0001, respectively) compared to those aged 18–24 years. Respondents born outside of Gauteng were at greater likelihood of HIV infection (AOR 2.3, 95% CI 1.3–4.0, p = 0.003). Women who had not completed secondary school were more likely to be HIV-infected than those who had completed their schooling (AOR 2.8, 95% CI 1.6–5.0, p = 0.0001). A partner's knowledge that a woman was selling sex was significantly associated with HIV infection (AOR 2.2, 95% CI 1.3–3.8, p = 0.005) as was having more than five clients (AOR 1.9, 95% CI 1.1–3.2, p = 0.02). Violence was non-significant in either model.

6.5. DISCUSSION

We found immense vulnerability among FSWs to HIV, with 53.6% infected overall. Our data also highlights the high burden of violence borne by this population. Structural factors, including the lack of completed education, and migrancy were strongly associated with HIV. Other factors strongly associated with HIV were having more than five clients a day and/or a partner knowing that sex was sold. Age was also an associated factor. Contrary to expectations, inconsistent condom use and binge drinking were not significantly associated with HIV status.

Our findings add to a growing body of evidence highlighting that many FSWs in South Africa have a substantially higher burden of disease than the pooled prevalence of 36.9% documented across sub-Saharan Africa, or the 11.8% reported in 50 countries in 2012 [60]. The findings suggest that FSWs in Soweto have an HIV prevalence substantially higher than the South African national average, and of women aged 25 years and older [267]. Prevalence among FSWs in Soweto is also higher than previously recorded among women who have engaged in transactional sex in the township (44.8%) [34]. However, the prevalence in our study was lower than that documented among FSWs in the Johannesburg site of the SAHMS, where prevalence was reported at 73.1% [16]. The Johannesburg study included a large inner-city immigrant population (31.5%) [16]. In comparison, only 16 FSWs in our study reported having immigrated from another country. This may have been an aggravating factor in the higher prevalence rates reported for Johannesburg, given that 70.6% of migrant FSWs were HIV-infected. Despite the few cross-border migrants, our study confirms the need for interventions geared towards migrant SWs. It further provides evidence of the need for structural level changes to laws and policies which perpetuate HIV vulnerability among FSWs [4].

The importance of education was shown as a key driving factor in the vulnerability of FSWs to HIV. South Africa has a checkered socio-political history, which has led to poor educational outcomes for many women [33, 270]. We found that 75% of FSWs reported incomplete education, compared with 58% in the general population [271]. Poor educational outcomes [33, 270] have been found to fuel an informal sex-for-money economy [4, 33], which increases the likelihood of HIV. South Africa has an unemployment rate of 27.1% [272], and people with secondary school qualifications have a distinct advantage over their uneducated counterparts in obtaining employment within the formal economy. In our view, the overall low levels of education found in our study contribute in multiple ways to increased vulnerability to HIV and economic marginalization.

Our findings highlight the vulnerability of women over 25 years, and the substantial burden of disease among women over 30 years, two thirds of whom were HIV-infected. Research has shown HIV prevalence peaking in FSWs in Cape Town and Durban for women of a similar age [16]. By comparison, HIV prevalence in Johannesburg was previously found to peak in sex workers aged 16–24 years [16]. One study, which included a small convenience sample of FSWs, found that the risk of HIV decreased with age [61]. Our study, however, suggests that interventions geared toward HIV prevention among SWs <30 years is vital in addressing FSW vulnerability to HIV acquisition. It further highlights the need for strong HIV treatment programs for women >30 years in Soweto.

We have found very high levels of violence among FSWs in South Africa. These findings are consistent with those of the SAHMS, in which half the FSWs reported physical violence, compared with 53.8% in the present study. However, more than twice as many women reported sexual assault in our study as the number of assaults reported in the SAHMS (55.5% versus 21.9%, respectively) [16]. Our prevalence of IPV is almost double that reported by women in the general population in Gauteng (25.3%), but three times that of women reporting IPV (18%) [207]. This study adds to a growing body of literature emphasising the high levels of violence in South Africa and, in particular, those to which SWs are exposed [4, 11, 12, 16, 26, 34, 53, 69, 71]. Despite violence having reached epidemic proportions, South Africa has no national strategy to prevent violence against women. This situation is compounded by the continued criminalisation of sex work, which hampers SWs' ability to report rape and assault, and perpetuates discrimination, which often incites violence against SWs.

Correct and consistent condom use in the past month was not associated with HIV-infection in this study. While consistent condom use is effective in preventing HIV infection [11, 140], it is unlikely that these FSWs became infected within this timeframe. This null finding may indicate that FSWs are less likely to protect themselves once they discover an HIV-positive status. However, future research is required to elaborate more substantially on this possible explanation for poor condom use.

Our findings suggest that condom use at last sex may be both an inflated and inadequate measure of consistent condom use. Shai et al[221] highlight the importance of multiple measures of condom use to develop an adequate understanding of consistency over time. Using a similar measure, we observed a decline in consistency between condom use at last sex (85%) and our measure of correct and consistent condom use (22.3%). While recent trends have indicated that SWs consistently use condoms with their clients [16, 72], our findings suggest that a new measure of condom consistency is required. Furthermore, the extremely low correct and consistent condom use reported in the Soweto environment is alarming, particularly given the mass promotion of condoms as a safe sex mechanism. In this environment, usage may be influenced by other factors such as exposure to violence [34, 73], which has been reported to be high across the township [178]. Further research is required to understand mechanisms inhibiting the uptake of consistent condom use.

Approximately three quarters of respondents had not told their partners that they engaged in sex work. Three quarters of those who had disclosed their profession were HIV-infected, more than half of whom reported condom use with their IP, possibly to protect him. It is likely that an IP's knowledge of a SW's profession stems from the IP being a former client. Thus, knowledge of her vocation may be mediating the relationship between other partner related factors and HIV vulnerability. This requires further research to understand what partner factors relating to knowing that sex is sold, play a role in HIV vulnerability.

This study describes a previously undocumented subset of FSWs who are based within Soweto, an urban African township on the outskirts of Johannesburg, Gauteng. Contrary to former accounts in the literature [11, 126, 268], FSWs in Soweto work largely in taverns or informal drinking establishments, and hostels. While transactional-sex relationships in Soweto have been described previously [10, 26], our study highlights the impoverished nature of FSWs in Soweto, many of whom enter the sex work industry as a means of survival. Dry sex or douching was bivariably

associated with HIV, and may indicate the increased vaginal cleaning practices associated with more common vaginal infections for HIV-positive women[77]. By contrast, FSWs in Kenya were twice as likely to acquire HIV if they douched with water and almost four-times the likelihood of HIV from douching with soap [78]. The use of lubricant and the practice of hiding menstrual blood by inserting an object into the vagina have not been well documented in the literature. Hiding menstrual blood has been anecdotally documented by local SW organisations. The practice involves the insertion of objects such as a kitchen sponge, cotton wool, a cloth, or tampon into the vaginal canal to prevent blood from showing during and after the sale of sexual services. In a sub-analysis, hiding menstrual blood was found to be associated both with reporting recent STI symptoms and client violence (analysis not shown). STI symptoms were associated with increased vulnerability to HIV. This suggests that it is vital that SW-specific practices need to be better documented and understood to ensure that interventions can be developed which are both appropriate to the FSW community and target their vulnerability to HIV.

Our study had several limitations including insufficient information on the temporal sequencing of HIV seroconversion and associated factors such as migrancy, entry into sex work, condom use and alcohol consumption. Implicit in the analysis is the assumption that HIV seroconversion followed these associated factors, but we are unable to confirm that this is the case. Our analysis assumed that recent sexual behaviour is indicative of past sexual behaviours, but caution should be taken in interpreting these results. Some variation was observed between adjusted and unadjusted bivariate analysis in the RDS analysis; understanding of the use of RDS weights in multivariate analysis is limited [273, 274]. However, the difference between adjusted and unadjusted analyses suggests that when used in conjunction with sensitivity tests, RDS data provide an alternative model for use in weighted multivariate logistic analyses. The RDS strategy was found to be a useful recruiting mechanism to reach FSWs in Soweto. However, care must be taken in screening potential participants to ensure that they do sell sex. Importantly, it is vital that more complex analyses are

conducted on SW data to unpack the complex interplay of causal mechanisms leading to their vulnerability to HIV, which are likely to be non-linear in nature.

HIV prevalence among FSWs in South Africa is excessively high and requires urgent action to arrest the unabated growth of the disease. Our findings highlight the vulnerability of FSWs to the disease, which is strongly driven by a combination of structural, biological and behavioural determinants. Soweto represents a microcosm of South Africa in terms of the epidemic of violence and HIV plaguing society, and which is often beyond the control of individuals. The South African government needs to urgently address structural factors impacting entry into and practices used in sex work. These factors often function in highly complex ways, and require innovative and alternative thinking beyond the scope of traditional HIV prevention and treatment. This would ensure that SWs are empowered to protect themselves effectively against HIV. This study also highlights the need for improved access to ART services as both a treatment and prevention strategy. At the same time, our findings suggest that there may be more immediate concerns facing FSWs which require more urgent attention. In line with Shannon et al [4, 275], these individual and structural level factors function to drive the epidemic and require inclusion within SW HIV programs. In the case of SWs, capacity development in the form of adult education, coping skills and mindfulness practices may prove valuable tools in the HIV armoury. Furthermore, in comparison to the SAHMS findings [16], these findings highlight the critical value of profiling a given population to ensure that interventions are contextually tailored. Such action will ensure that access to treatment and prevention through rights-based services is effectively implemented in South Africa in line with the *South African National Sex Worker HIV Plan 2016–2020 [59]*.

Table 6-2 HIV prevalence and demographic characteristics by HIV status for female Soweto-based sex workers, including raw percentages and adjusted population level prevalence with 95% confidence intervals for both univariate and bivariate analysis showing row per

Variable (n = 508)	Overall		HIV +		HIV -	
	Raw n (%)	RDS Adjusted % (95%	Raw n(%)	RDS Adjusted %	Raw n(%)	RDS Adjusted %
HIV prevalence						
HIV-infected	280 (55.1)	53.6 (47.5–59.9)	-	-	-	-
HIV-negative	228 (44.9)	46.4 (40.4–52.4)	-	-	-	-
Age						
18–24	124 (24.4)	23.5 (18.5–29.1)	41 (33.1)	28.8 (19.0–29.0)	83 (66.9)	71.2 (61.0–81.1)
25–29	114 (22.4)	20.9 (16.2–25.7)	57 (50.00)	48.7 (35.0–60.2)	57 (50.0)	51.3 (39.6–64.1)
≥30	270 (53.2)	55.6 (49.2–61.9)	182 (67.4)	65.6 (57.7–73.7)	88 (32.5)	34.4 (26.6–42.1)
Home language						
Zulu	274 (53.9)	52.3 (46–59.5)	156 (56.9)	54.7 (47.0–63.3)	118 (43.1)	45.3 (36.8–53.7)
Sotho	131 (25.8)	26.7 (20.5–32.5)	70 (53.4)	51.1 (40.2–63.2)	61 (46.6)	48.9 (36.4–60.3)
Other	103 (25.8)	21 (15.9–26.2)	54 (52.4)	54.5 (40.5–67.1)	49 (47.6)	45.5 (33.0–58.8)
Place of birth						
Gauteng	346 (68.1)	71.6 (64.6–77.2)	172 (49.7)	46.9 (40.2–54.1)	174 (50.3)	53.1 (45.5–60.0)
Other (includes cross-border migrants)	162 (31.9)	28.5 (22.7–35.4)	108 (66.7)	70.6 (60.9–78.6)	54 (33.3)	29.4 (21.2–39.0)
Education						
Incomplete schooling	384 (75.6)	74.2 (69.2–79.9)	234 (60.9)	60.1 (53.8–66.6)	150 (39.1)	39.9 (33.2–46.4)
Secondary complete/some tertiary	124 (24.4)	25.8 (20.4–30.9)	46 (37.1)	34.7 (23.2–47.0)	78 (62.9)	65.3 (53.1–76.7)
Number children						
No children	82 (16.1)	13.2 (9.8–17.1)	36 (43.9)	38.4 (25.3–54.3)	46 (56.1)	61.1 (45.8–75.4)
One child	164 (32.3)	32.2 (27.0–37.9)	79 (48.2)	45.6 (36.4–56.8)	85 (51.8)	54.4 (43.1–63.9)
Two children	153 (30.1)	33.5 (28.1–39.0)	93 (60.8)	59.8 (48.2–69.9)	60 (39.2)	40.2 (30.0–51.0)
≥ Three children	109 (21.5)	21.1 (16.8–25.6)	72 (66.1)	64.3 (53.4–75.0)	37 (33.9)	35.7 (24.7–46.8)

Table 6-3 Sexual risk factors characteristics by HIV status for female Soweto based sex workers, including raw percentages and adjusted population level prevalence with 95% confidence intervals for both univariate and bivariate analysis showing row percentage.

Variable (n = 508)	Overall		HIV +		HIV –	
	Raw n (%)	RDS Adjusted	Raw n (%)	RDS Adjusted	Raw n (%)	RDS Adjusted
Age first sex						
4–15 years	157 (30.9)	30.9 (25.9–35.9)	94 (33.6)	58.4 (48.0–68.2)	63 (27.6)	41.6 (32.6–52.0)
16–25 years	351 (69.1)	69.1 (63.9–74.1)	186 (66.4)	51.5 (44.5–58.9)	165 (72.4)	48.5 (41.1–55.5)
Length of time selling sex						
1–2 years	171 (33.7)	38.5 (32.5–45.1)	73 (42.7)	44.1 (34.6–53.3)	98 (57.3)	55.9 (46.7–65.5)
3–7 years	233 (45.9)	41.4 (35.3–46.8)	136 (58.4)	57.8 (48.7–65.3)	97 (41.6)	42.2 (35.1–51.4)
8–33 years	104 (20.5)	20.1 (15.4–25.6)	71 (68.3)	63.5 (50.1–76.9)	33 (31.7)	36.5 (23.1–49.5)
Partner knows sex is sold						
Partner does not know	364 (72.4)	80.1 (74.3–84.3)	183 (50.3)	48.8 (42.5–55.8)	181 (49.7)	51.2 (44.4–57.7)
Partner knows	139 (27.6)	19.9 (15.7–25.2)	94 (67.6)	74.2 (65.4–83.3)	45 (32.4)	25.8 (16.8–34.8)
Number clients in the past day						
0–4	219 (43.1)	43.4 (37.3–48.9)	107 (48.9)	46.1 (37.1–55.9)	112 (51.1)	53.9 (43.7–62.6)
5–19	289 (56.9)	56.6 (50.7–62.5)	173 (59.9)	59.7 (52.1–66.8)	116 (40.1)	40.3 (32.8–48.2)
Daily earning potential/client						
≤R50.00	350 (68.9)	70.4 (64.6–75.3)	199 (56.9)	55.8 (49.3–63.1)	151 (43.1)	44.2 (37.0–50.8)
>R50.00	158 (31.1)	29.6 (24.8–35.5)	81 (51.3)	48.6 (38.4–59.0)	77 (48.7)	51.4 (40.9–61.6)
Inconsistent & problematic condom use						
Consistent condom usage	122 (24.0)	22.3 (117.9–27.5)	65 (53.3)	53.9 (43.2–65.1)	57 (46.7)	46.1 (34.8–56.7)
Inconsistent condom usage	386 (76.0)	77.7 (72.3–82.2)	215 (55.7)	53.6 (46.4–60.4)	171 (44.3)	46.4 (39.3–53.6)
Dry sex in the past month						
Dry sex reported	129 (25.4)	24.9 (20.4–29.4)	198 (52.2)	67.7 (56.1–76.5)	181 (47.8)	32.3 (23.0–44.5)
No dry sex reported	379 (74.6)	75.1 (70.7–79.8)	82 (63.6)	48.9 (42.3–56.3)	47 (36.4)	51.1 (43.5–57.6)

STI symptoms in the past 6 months						
STI symptoms	259 (51.0)	49.8 (43.9–55.7)	157 (60.6)	61.2 (53.1–68.9)	102 (39.4)	38.8 (30.5–46.7)
No STI symptoms	249 (49.0)	50.2 (44.3–56.1)	123 (49.4)	46.1 (37.7–54.6)	126 (50.6)	53.9 (46.1–62.2)
Most popular pick-up location						
Hostel used as a pick-up location	306 (60.2)	52.2 (45.8–59.6)	178 (58.2)	55.7 (47.2–63.6)	128 (41.8)	44.3 (36.6–53.0)
Other locations used	202 (39.8)	48.0 (40.4–54.5)	102 (50.5)	51.8 (43.2–61.2)	100 (49.5)	48.2 (38.8–56.5)
Binge drinking (including volume per drink)						
Low-level drinking	127 (25%)	23.8 (19.1–28.6)	64 (22.9)	21.8 (15.4–28.5)	63 (27.6)	26.7 (19.6–35.5)
High-level drinking	381 (75%)	76.2 (71.2–81.2)	216 (77.1)	78.2 (71.8–84.7)	165 (72.4)	73.3 (64.1–80.6)
IP physical/sexual violence ever						
None	220 (43.3)	46.2 (40.4–51.9)	123 (55.9)	56.7 (48.3–64.9)	97 (44.1)	43.3 (34.7–51.9)
Some	288 (56.7)	53.8 (48.1–59.6)	157 (54.5)	50.8 (42.8–58.5)	131 (45.5)	49.2 (40.9–57.5)
Sexual violence by non–IP						
None	231 (45.5)	44.5(38.6-49.8)	112(48.5)	46.2(37.1-54.2)	119(51.5)	53.8(45.4-63.0)
Some	277 (54.5)	55.5(50.2-61.4)	168(60.7)	59.6(52.4-67.5)	109(39.4)	40.4(33.1-48.0)

Table 6-4 Univariate description of female sex work practices and behaviours not included in bivariate or multivariate analyses, including raw percentages and adjusted population level prevalence with 95% confidence intervals.

Variable (n = 508)	Raw n(%)	RDS Adjusted % (95% CI)
Circumstances behind entry into SW		
No income food/shelter/kicked out	144 (28.4)	28.6 (22.4–33.4)
Nowhere to stay/orphan/widow/deserted	49 (9.7)	9.1 (5.9–12.5)
Family income	211 (41.54)	39.4 (35.0–47.3)
Teenage pregnancy	14 (2.8)	3.6 (1.5–6.0)
Fast money/personal expenses	62 (12.2)	13.0 (9.1–16.4)
Other	28 (5.5)	6.3 (3.4–9.4)
Venues within which FSWs sell sex in Soweto *		
Taverns	416 (81.9)	85.6 (81.2–89.3)
Hostels	306 (60.2)	52.0 (45.5–59.4)
Brothels	77 (15.2)	14.2 (10.4–18.1)
Hotels	35 (6.9)	6.6 (4.2–9.8)
Street	49 (9.7)	8.4 (5.5–11.5)
Most popular service		
Vaginal sex	453 (89.2)	89.5 (85.9–93.0)
Anal sex	35 (6.9)	6.6 (4.0–9.5)
Oral sex	14 (2.8)	2.9 (1.2–4.9)
Other (dinner, massage, phone, hand-job, stripping, other)	6 (1.2)	0.3 (0.0–0.6)
Lubricant used during sex*	247 (48.6)	47.3 (41.1–53.5)
Lubricant	225 (44.3)	43.2 (37.7–49.4)
Saliva	15 (3.0)	2.9 (1.5–4.6)
Vaseline	20 (3.9)	3.8 (1.7–6.2)
Baby oil	30 (5.9)	4.1 (2.4–6.3)
Hiding menstrual blood while selling sex *	182 (35.8)	32.1 (27.2–37.8)
Tampon	17 (3.4)	3.2 (1.4–5.6)
Kitchen sponge	59 (11.6)	10.4 (7.1–13.9)
Cotton wool	67 (13.2)	11.6 (8.0–15.3)

Red coloured condom	81 (15.9)	14.3 (10.7–18.3)

* multiple responses permitted

Table 6-5 Logistic regression analysis of factors affecting HIV seropositive status of female sex workers in a South African township, with both weighted and unweighted multivariate analysis displayed.

Variable (n = 502)	Unweighted AOR (95% CI)	P-value	Weighted AOR (95% CI)	P-value
Age (categorised along IQR)				
18–25	(ref)	-	(ref)	-
26–30	2.2 (1.3–3.9)	**0.005**	2.9 (1.3–6.3)	**0.008**
31+	4.2 (2.6–6.8)	**0.0001**	4.9 (2.6–9.3)	**0.0001**
Place of birth				
Gauteng	(ref)	-	(ref)	-
Other (includes cross-border migrants)	1.7 (1.1–2.6)	**0.018**	2.3 (1.3–4.0)	**0.003**
Education				
Incomplete secondary schooling	2.7 (1.7–4.3)	**0.0001**	2.8 (1.6–5.0)	**0.0001**
Secondary completed /some tertiary	(ref)	-	(ref)	-
Partner knows she sells sex				
Partner does not know	(ref)	-	(ref)	-
Partner knows	1.7 (1.0-2.7)	**0.031**	2.2 (1.3–3.8)	**0.005**
No. of clients in the past day				
0–4	(ref)	-	(ref)	-
5–19	1.7 (1.2–2.6)	**0.005**	1.9 (1.1–3.2)	**0.02**

7. CHAPTER SEVEN: HIV-1 VIRAL INFECTIVITY AND DRUG RESISTANCE AMONGST FEMALE SEX WORKERS IN SOWETO, SOUTH AFRICA: A CROSS SECTIONAL STUDY

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Table 7-1 Author Contributions Paper Four

AUTHOR	CONTRIBUTIONS
Jenny Coetzee	Conceptualisation, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, resources, software, software, supervision, validation, visualisation, writing – original draft, writing – review & editing
Gillian Hunt	Conceptualisation, project administration, resources, software, software, supervision, validation, writing – review & editing
Maya Jaffer	Conceptualisation, methodology, formal analysis, writing – review & editing
Kennedy Otwombe	Conceptualisation, investigation, methodology, writing – review & editing
Lesley Scott	Conceptualisation, project administration, resources, software, software, supervision, validation, writing – review & editing
A Bongwe	Investigation, project administration, resources, writing – review & editing
J Ledwaba	Investigation, project administration, resources, writing – review & editing
Sephonono Molema	Investigation, project administration, resources, writing – review & editing
Rachel Jewkes	Conceptualisation, investigation, methodology, supervision, writing – review & editing
Glenda E Gray	Conceptualisation, investigation, methodology, supervision, writing – review & editing

7.1. ABSTRACT

Background HIV drug resistance (HIVDR) poses a threat to future antiretroviral therapy success. Monitoring HIVDR patterns is of particular importance in populations such as sex workers (SWs), where documented HIV prevalence is between 34-89% , and in countries with limited therapeutic options. Currently in South Africa, there is a dearth in evidence and no ongoing surveillance of HIVDR amongst sex work populations. This study aims to describe the prevalence of HIVDR amongst a sample of female sex workers (FSWs) from Soweto, South Africa

Methodology A cross-sectional, respondent driven sampling (RDS) recruitment methodology was used to enrol FSWs based in Soweto. Participants were tested for HIV and undertook a survey that included HIV knowledge and treatment status. Whole blood specimens were collected from HIV positive FSWs to measure for CD4 counts, viral load (VL) and perform HIVDR genotyping. Frequencies were determined for categorical variables and medians and interquartile ranges (IQR) for the continuous.

Results Of the 508 enrolled participants, 55% (n=280) were HIV positive and of median age 32 (IQR: 20-51) years. Among the HIV positive, 51.8% (132/269) were defined as virologically suppressed (VL < 400 copies/ml). Of the 119 individuals with unsuppressed viral loads who were successfully genotyped for resistance testing 37.8% (45/119) had detectable drug resistance. In this group, HIVDR mutations were found amongst 73.7% (14/19) of individuals on treatment, 27.4% (26/95) of individuals who were treatment naïve, and 100% (5/5) of defaulters. One phylogenetic cluster was found amongst treatment naïve FSWs. The K103N mutation was detected most commonly in 68.9% (31/45) individuals with HIVDR mutations, with 20/26 (76.9%) of treatment naïve FSW with detectable resistance having this mutation. The M184V mutation was found in both FSWs on treatment (12/14, 85.7%) and those defaulting (1/5, 20.0%).

Discussion More than one third (45/119) of the genotyped sample had HIVDR, with resistance to the NNRTI class being the most common. Almost half of HIV positive FSWs had unsuppressed viral loads, increasing the likelihood for onward transmission of HIV. Disturbingly, more than 1:4 treatment naïve women with unsuppressed viral loads had HIVDR suggesting that possible sexual transmission of drug resistance is occurring in this high-risk population. Given the high burden of HIVDR in a population with a high background prevalence of HIV, it is imperative that routine monitoring of HIVDR be implemented. Understanding transmission dynamics of HIVDR in FSW and its impact on treatment success should be urgently elucidated.

7.2. BACKGROUND

HIV drug resistance (HIVDR) to first and second line antiretroviral (ART) regimens pose serious limitations to therapy success. Thus the prevention thereof has become a global priority[89]. Given the high HIV prevalence found in sex worker (SW) populations and the roll-out of the *South African National Sex Worker HIV Plan 2016-2020 [59]*, which sees the provision of access to universal test and treat (UTT), it is critical that we begin to understand HIVDR amongst SWs. This is especially important when considering the limited evidence currently available on HIVDR amongst SWs in South Africa. In the event that a significant proportion of the population develop, transmit or acquire HIVDR, the gains made in treating and preventing HIV in recent years would potentially be lost [90].

South Africa has the largest ART program in the world, with 3 million people initiated during 2015. The country is also scaling up service delivery to SWs as a means to curb the epidemic [59]. While survival, quality of life, and prevention are improved through such efforts, the risk of HIV drug resistance (HIVDR) mutations increases as more people are placed on ART[90, 91]. Longer lifetimes on ART allows for more time for resistance to develop, and pressure on the public health system may lead to events such as drug-stock outs, in turn leading to treatment interruptions [92]. Compounded

by the infrequency of viral load (VL) monitoring and that appropriate action in the face of virologic failure may not always be taken, patients may continue on failing regimens, with an accumulation of HIVDR mutations developing [90]. An accumulation of drug resistant mutations may be a risk even when adherence results in viral suppression, due to multiple infections and the additional sexual acquisition of transmitted drug resistance (TDR). In South Africa, provision is largely made for HIVDR testing as a prerequisite to initiating a third line regimen. At present HIVDR testing is usually available through centralised processes in government clinics and hospitals in Southern Africa – primarily because of issues around laboratory capacity and because the results may be poorly understood by non-specialist clinicians [93].Data from the WHO suggests that between 2013-2014 in South Africa, while 100% of clinics were reported to prescribe ART, retention in care was 67.8% and only 27.2% of patients collected their ART pills on time, both early warning signs for the development of HIVDR[90].

The WHO's 2012 drug resistance report highlights the potential of increasing HIV drug resistance – both acquired drug resistance (ADR) which is a result of drug selection pressure, and TDR, when an individual with no exposure to ART is infected with virus that has existing drug-resistant mutations [92]. A meta-analysis of data from South Africa during 2000-2010 did not find any increase in TDR, and suggested that South Africa falls into what the WHO classifies as a "low prevalence" country for TDR, with less than 5% TDR[94]. However, more recent data suggests that drug resistance is indeed increasing. In low-middle income countries, the WHO reported levels of HIVDR to increase between 2004-2014, with higher levels of TDR being seen amongst treatment naïve individuals, particularly to non-nucleoside reverse transcriptase inhibitors (NNRTIs), currently used in many first-line ART regimens [92]. In South Africa, data from a NICD study released in 2016 reported TDR at 14% [90, 95]. Modelling estimates of the South African epidemic suggest that by 2032, should a test and treat strategy result in ART initiation irrespective of CD4 count, with no other changes to diagnosis and retention rates, HIVDR to NNRTIs will be present amongst 32% of the total HIV positive

population, and that 30% of these (9.6% of the total HIV positive population) will also have a VL ≥500 copies/ml meaning they are infectious [96].

Moderate levels of HIVDR (9%, 25/277) was found amongst pre-treatment patients from a sample of clinics across South Africa between 2013-2014 [97]. In addition, evidence from KwaZulu Natal found that amongst adults who had recently been diagnosed (≤ 24 months), 7.1% had some form of resistant mutation, with the most common NNRTI mutation being K103N (27, 3.8%). NRTI resistant mutations were detected in 10 (1.4%) adults with 8 having only a single NRTI mutation[98]. A 24-week prospective study of treatment naïve HIV positive individuals in Uganda found that treatment interruptions >48 hours could result in drug resistance (13%) [99].

Extremely high HIV prevalence has been documented amongst female sex workers (FSWs) in South Africa. The 2013 *South African Health Monitoring Survey* (SAHMS) found levels in Johannesburg, Durban and Cape Town of 71.6% , 53.5% , and 39.7% [16]. The study also found that knowledge of HIV status was high amongst female sex workers (FSWs), yet uptake of treatment was poor (23.4 - 45.3%). In Johannesburg for example, 38% of FSWs knew their status but were treatment naive, of HIV positive FSWs, 21.6% were unaware of their HIV status, and only 12.2% of known positive FSWs were on ART [16]. A cross sectional survey of women selling sex along a major trucking route, showed an HIV prevalence of 89.9% [18]. The sample presented within this paper had an adjusted HIV prevalence of 53.1% for FSWs in Soweto[146]. Sex worker vulnerability to HIV is driven by several factors including sexually risky behaviour and violence[16, 145, 146]. Evidence has shown men who purchase sex are more like to engage in sexually risky behaviours such as violence and poor condom uptake [27, 138, 151]. Violent men are also more likely to be HIV positive[151], and violence is significantly associated with treatment defaulting [1] which is a key factor in developing HIVDR. Together, these highlight the possible vulnerability of FSWs to

HIVDR. In addition, recreational drugs with a combination of marijuana, heroin and ARVs are growing in popularity in South African townships, yet nothing is known about its impact on HIVDR.

Regular surveillance for HIVDR in key affected groups such as SWs, is not routinely undertaken in South Africa, and available evidence globally is based upon very small samples from only a few locations. Amongst SW populations within Kenya, evidence suggests a 22% prevalence of HIVDR [101]. An unpublished Kenyan study suggested that 8.3% of ARV treated FSWs within the Pumwani cohort had HIVDR (5/60)[102]. Studies of SWs in Argentina have found HIVDR in 12/62 (19%) [103], and 3/16 (18.8%) [104]. A 2005 study of FSWs and injecting drug users (n=11) along the US-Mexico border found two out of three drug naïve FSWs to have low-level resistance mutations. In addressing the dearth of data on HIVDR amongst the sex work population, this study aims to describe the prevalence of HIVDR mutations amongst a sample of FSWs from Soweto, South Africa.

7.3. METHODOLOGY

We present an analysis from a convenience sample of HIV positive FSWs from a larger cross-sectional, respondent driven sampling survey. We previously reported the overarching methodology, baseline characteristics and population-level prevalence of HIV in the overarching study [146]. The study was nested within an existing sex work program at the Perinatal HIV Research Unit in Soweto, South Africa. The surrounding township is on the outskirts of Southern Johannesburg, predominantly urban and peri-urban, low-income with limited educational and employment opportunities. It comprises >40 suburbs within 61km^2, is estimated to house >2 million inhabitants and has > 3,000 drinking establishments. The sex work program fixed clinic was used as a base for this study. Respondent driven sampling (RDS) recruitment was used in line with the guidelines provided by the World Health Organisation[252]. This method is a popular way to recruit marginalised populations [236, 237].

Recruitment was undertaken between February-September 2016 (n=508). Inclusion criteria for the present study was enrolment into the larger study (biologically female, >18 years, currently engaged in the sale of sexual services in Soweto, knew their recruiter, and gave voluntary informed consent to participate in both the survey and HIV testing), and tested HIV positive. A VL must have been successfully undertaken, and if VL ≥500 copies/ml then HIVDR genotyping was performed. To avoid duplicate enrolment, fingerprints (left, index finger) were scanned and an algorithm recorded and compared for every enrolment using the FingerTec OFIS system (http://www.fingertec.com/images/brochure/Ofis-E.pdf).

After screening, participants completed a 45-minute, interviewer-administered questionnaire and then underwent HIV counselling and testing. Using the WHO guidelines, two rapid tests were conducted[238]. HIV positive participants underwent a venous blood draw for CD4, VL and HIVDR genotyping. Participants were provided with a maximum of three uniquely coded coupons to refer other FSWs to the study and reimbursed R100.00 ($7.69), later increased to R120.00 ($9.25) due to additional costs to participate. A further R20.00 ($1.56) was paid for recruiting other participants into the study.

HIV VL testing were performed using the Abbott RealTi*m*e HIV-1 assay (Abbott Molecular, Des Plaines, Il)by Clinical Laboratory Services (CLS, Johannesburg, South Africa) within 40minutes road transport from the clinic collection site for same day VL testing service. CD4 enumeration was conducted by the National Health Laboratory Service (NHLS) as part of standard of care, using the PanLeucogating (PLG) technology (Beckman Coulter, Miami, Fl). Drug resistance genotyping was undertaken by the National Institute of Communicable Diseases (NICD). Sequencing of the polymerase gene was performed using a validated in-house assay [240]. The procedure involved the generation of a nested PCR amplicon spanning the entire protease and p66 and p51 regions of the reverse transcriptase genes. Genotypic resistance was defined as the presence of resistance mutations

associated with impaired drug susceptibility, using the Stanford University HIV Drug Resistance Database (https://hivdb.stanford.edu/). Phylogenetic analysis of nucleic sequences was performed using an HKY85 model to establish linkages using PAUP, and rates of transmission of resistance determined by calculating point prevalence with confidence intervals.

Survey data and HIV test results were collected during interviews directly onto Lenovo tablets into the REDCap electronic data management system[254], hosted by the University of the Witwatersrand, South Africa. The database housed built-in skip patterns and algorithms, with missing values being highlighted before an interviewer could move to the next survey section. Data could be viewed live on the REDCap database to ensure that queries were rapidly addressed before participants left the study site. The system also enabled interviewers to insert detailed comments or explanations on responses they wished to discuss. A 48-hour response-time to checking and closing queries was implemented during the study. This aided in ensuring high quality data was consistently captured. VL, CD4 and drug resistance data was captured into the system as it became available, using participant's unique identifier to match results. Duplicate data were collected on a convenience sample of 12% of the overall sample with an error rate of 0.6%. Twenty-one CD4 results were either lost or rejected by the NHLS for reasons unrelated to the study. Ethical approval for this study was provided by the Human Research Ethics Committee (Medical) of the University of the Witwatersrand, South Africa (M150740).

7.3.1 MEASURES

Drug resistance mutations were indicated as present or absent. All mutations were categorised to indicate NNRTI, NRTI or PI genotypes. Rates of HIVDR were analysed according to self-report treatment history.

Participants were asked their treatment history, with questions being asked dependent on a skip pattern of having tested and taking treatment. Questions were: "Have you previously tested for

HIV?" (yes/no) "What was your test result?" (I do not know, negative, positive, indeterminate), "Are you on treatment?" (never taken, on treatment always, stopped taking treatment), and "In the past week how many times have you taken your treatment?" (all 7 days, 5-6 days, 3-4 days, 1-2 days, not at all). Interviewers were trained to probe for PMTCT history, and the nurse confirmed previous ART history. A new variable was then created indicating self-report treatment history as: treatment naïve (either unknown positive and never taken treatment, or known positive but never taken treatment); treatment defaulting (known positive and stopped taking treatment or treatment taken for ≤5-6 days of the past week); on treatment (known positive, on treatment always and treatment taken all 7 days). Participants were asked about their use of Nyoape, the colloquial name for a recreational drug consisting of marijuana, heroin and ARVs, only three responses reported using the drug, one was HIV positive and treatment naïve. The measure was dropped.

7.3.2 STATISTICAL ANALYSIS

Log transformations were performed on VLs that were capped at 750,000 copies/ml. VL was evaluated in 2 ways: as a log-transformed continuous measure, and dichotomised with a cutoff of ≥400 copies/ml for viral suppression. CD4 count was assessed as a continuous measure. Frequencies were determined for categorical measures whereas continuous measures were assessed by medians and interquartile ranges. Continuous measures of the HIV positive participants stratified by a cut-off of ≥400 copies/ml were compared non-parametrically using studentized t-test. Two participants with VLs between 400 - 500 were classified as unsuppressed, but not genotyped and so dropped from the analysis. Data were analysed by STATA13 [276].

7.4. RESULTS

As shown in Table 7-2, HIV tests were done on 508 FSWs, with 55.1% (280/508) being HIV positive. Viral load RNA measurements were done on 96.1% (269/280) of HIV positive samples with 49.1% (132/269) of these being ≥ 400 copies/ml and defined as unsuppressed. 90.2% (119/132) were

successfully amplified and sequenced for HIVDR genotyping, and 37.8% (45/119) having evidence of HIVDR mutations. Viral load or genotyping could not be done (n=13) due to: one refused blood draw, one failed blood draw, two viral load between 400-500, four samples were haemolysed and five missing.

Table 7-3 presents summary characteristics for all HIV positive FSWs. The median age in Soweto was 32 (20-51) years, with CD4 being 473 (311-701) cells/mm^3, and VL $\log_{10}$ being 2.4 (1.6-4.0). 51,8% (141/269) of HIV positive FSWs had a VL <400 copies/ml which in this study was defined as viral suppression. Drug resistance genotyping was only done on participants with VLs ≥400 (n=119). The total proportion of HIV positive SWs who self-reported being on treatment was 43,9% (118/269), 50.6% (136/269) were treatment naïve, and 5.6% (15/269) were defaulting treatment. Overall one phylogenetic cluster was found comprising 2 participants.

Also presented in Table 7-3 are HIV positive participants with a VL < 400 copies/ml. The median age was 34.1 years and CD4 count was 623.8 cells/mm^3. The median VL $\log_{10}$ was 1.7 (1.6-1.7). By comparison, of FSWs with a VL ≥400 and who were successfully genotyped (n=119), the median age was 30 years and CD4 count was 419 cells/mm^3. The median VL $\log_{10}$ was 4.2(4.0-4.3), 79.8% (95/119) self-reported treatment naïve, 16.0% (19/119) self-reported being on treatment , and 4.2% (5/119) were defaulting their treatment. Detectable HIVDR was found in 37.8% (45/119). NNRTI only resistance was detected in 24.2% (29/119), NRTI only amongst 0.9% (1/119), NNRTI and NRTI mutations amongst 10.9% (13/119), and NNRTI, NRTI and PI mutations amongst 1.7% (2/119).

Table 7-4 shows all participants successfully genotyped for HIVDR (n=119). For those reporting being treatment naïve (n=95), the median age was 30 (24-36) years, CD4 cell count was 381.5 (253-508) cells/mm^3, VL $\log_{10}$ was 4.1(3.3-4.8), and 81.8% were known positives (220/269). Resistance was detected in more than a quarter (27.4%, 26/95) of treatment naïve FSWs, 24.2% (23/95) had NNRTI only mutations, 3.1% (3/95) had NNRTI and NRTI mutations, and 1

phylogenetic cluster was detected. In the same table, those reporting being on treatment (n=19), the median age was 35 (29-40) years, CD4 count result was 285(96-530) cells/mm^3, VL $\log_{10}$ was 4.0(3.5-4.9), and 71.4% were known positives (85/119). Resistance was detected in 73.7% (14/19) of these participants. NNRTI only resistance mutations were detected in 10.5% (2/19), NRTI only mutations in 5.3% (1/19), NNRTI and NRTI mutations in 47.4% (9/19), and NNRTI, NRTI and PI mutations in 10.5% (2/19). Finally, amongst those reporting treatment defaulting (n=5), the median age was 33 (31-34) years, CD4 count result was 306 (195-526) cells/mm^3, VL $\log_{10}$ was 3.9(3.9-4.1), and 90.1% were known positives (127/141). Resistance was detected in 100% (5/5) of this subset. NNRTI only was detected in 80% (4/5) and NNRTI and NRTI in 20% (1/5).

Table 7-5 shows all resistance mutations by self-reported treatment. Amongst treatment naïve FSWs, 20 had the NNRTI mutations K103N, 4 had the K101E or V106E mutations. No PI mutations were seen in this group. For those on treatment (n=14), 7 had the K103N mutations and5 had the V106M or G190A mutations, and 2 and the K101E mutation. Amongst treatment defaulters (n=5), 4 had the K103N mutation and 1 had the V106M mutation. The NRTI mutation M184V was also found in 1 participant. Overall, the number of FSWs with the K103N mutation was 68.9% (31/45), the K101E mutation was found in 6/45 (13.3%), the V106M mutation in 10/45 (22.2%), the G190A in 5/45 (11.1%), and the NRTI mutation M184V was present in 13/45 (28.9%) of SWs.

7.5 DISCUSSION

This cross-sectional study examined HIV-1 drug resistance amongst FSWs in Soweto who had unsuppressed viral loads. Disturbingly we found that 1:4 FSWs who were treatment naïve had TDR. This highlights the vulnerability of FSWs in Soweto to the sexual acquisition of HIVDR, and the resulting impact upon both treatment options and long-term survival. Additionally, more than a third of FSWs who were not virally suppressed had HIVDR (45/119), and three quarters of those on treatment but failing to suppress had HIVDR (14/19). This suggests the importance of providing

services to SWs that they can actively engage in, and it highlights the importance of proactive monitoring of VL within sex work programs to ensure that timeous decisions are made in response to treatment failure. Clinical settings that provide services to SW may also be an environment to expand existing highly centralised VL testing services with technology capable of polyvalent testing (HIV VL, HPV and TB as example) that can be performed at the point of care. Such technology is becoming available such as the GeneXpert (Cepheid, Sunnyvale, CA) platform [277]. Furthermore, only mutations relating to first line regimens were found amongst treatment naïve SWs, highlighting the possibility that a quarter of FSWs will fail first line therapies for reasons unrelated to adherence. Our data highlights that most FSWs who are on treatment are adherent and virally suppressed. Findings also suggested that the VL of those who had HIVDR mutations was high, thus potentially resulting in the onward transmission of HIVDR in cases where mutations are more robust.

Our findings highlight the potential for sexually transmitted HIVDR. While, previous research has measured transmitted HIVDR at between 9-14% [96, 97], we found that more than one quarter (27,4%) of FSWs who were not virally suppressed and who reported being treatment naïve had HIVDR mutations. Research has previously shown that men who purchase sex are more likely to be HIV positive [151], not use condoms and have been found to be more violent when compared to men who do not purchase sex [27, 138, 149]. These partner behaviours in combination with the findings of this study highlight the increasing vulnerability of FSWs to HIV. Interventions which target partners of SWs are urgently needed to address both sexual risk behaviours and treatment adherence. Research is urgently needed to understand the prevalence of HIVDR amongst partners of FSWs and their transmission dynamics.

We found that the majority of FSWs in our study and who were on treatment (119/269), were virally suppressed (99/141). Extrapolating from this, we suggest that once on treatment, FSWs are likely to be adherent to their ART regimens. However, our data also shows that more than 75% of FSWs on

treatment who are not virally suppressed have compromise to their first line regimens because of HIVDR. These FSWs ideally need to be managed according to the national protocol for virologic failure, which may result in being switched to a second line regimen. Given our previous findings regardingTDR, it is also possible that some of these failures are due to the sexual acquisition of HIVDR and not non-adherence.

Amongst those who are on treatment or defaulting treatment, it is important to note that several factors limited the ability of FSW to be 100% ART compliant. Research has shown that SWs are exposed to high levels of violence [16, 202], and that violence impacts women's ability to be ART adherent [1]. Additionally, policing officials have been documented withholding access to ART for SWs in custody [14]. In addition, the population is particularly vulnerable to being displaced from the healthcare system. These factors are particularly critical in ensuring effective adherence to ART. We found that almost 75% of the sample who reported being on treatment but were failing to suppress had drug-resistant mutations – the most likely scenario is that these mutations represent acquired resistance, and it suggests that treatment interruptions have likely been experienced by these individuals. Given the complexities of their lives, many of these interruptions will likely be beyond the individual level of control and require renewed efforts to address the various structural factors which serve to drive the epidemic and SWs inability to effectively engage with health systems. Another finding among those on treatment with an unsuppressed viral load is that wildtype virus was identified upon genotypic testing in 26,3% of them (5/19). This illustrates another recognised use of drug resistance testing – the presence of wildtype virus in these individuals suggests non-adherence to treatment as the cause of the virologic failure [93]. This can avoid prematurely switching to a costly and burdensome second line regimen when the virus may still have been susceptible to the original one.

Drug resistance as a percentage of the total number of HIV positive participants in our study was higher than has previously been found amongst a SW cohort in Kenya (16.7% vs. 8.3%) [102]. Our findings were within a similar range to those from two Argentinian FSW studies (18.8-19%)[103, 104]. However, our study sample included individuals who were self-report treatment adherent as well as treatment naïve and treatment defaulters, whereas previous studies included only individuals on ART (verified and self-report, respectively). While modelling estimates suggest that in certain scenarios outlined previously HIVDR will be prevalent amongst 32% of the HIV positive population by 2032[96], our findings suggest that HIVDR may be increasing to this point as it is already at 16% amongst the Soweto SW population and that further research is urgently required to better understand this.

The finding that there was 1 phylogenetic cluster amongst treatment naïve FSWs adds to our concern in that it suggests a common source to their infection, who likely has multiple other partners, is inconsistent in condom use, [27, 138, 151] and may transmit HIVDR to other persons. In our study, less than half of FSWs had initiated ART and were currently on treatment, which was higher than in the SAHMS (45.6% versus 12.2%) [16]. This suggests that there are fundamental differences between FSWs in Soweto [146] from the overall metropolitan of Johannesburg [16]. This could it part be explained by the varying profiles of FSW between the township [146]. Similarly, to the SAHMS, we found that almost all FSWs in our study had previously tested for HIV, with < 20% of all HIV positive FSWs being unknown positives, and of these, less than one-third had unsuppressed viral loads. This suggests that FSWs in Soweto are testing for HIV and that there is the potential for linkage to care to initiate and monitor their response to treatment. Individuals with unsuppressed viral loads were also more likely to have a lower CD4 count than those who were virally suppressed, suggesting poorer health outcomes for a subset of our sample group. When considering the WHO 90-90-90 targets we see a mixed picture. The proportion of HIV positive participants who knew their own status was encouragingly high, 81.8%, approaching the 90% target. However, as shown and

discussed the other two WHO targets are far from being met, with only 43,9% already on ART treatment, and 70,2% of those on treatment who are virally suppressed. This of course impacted by the high number of drug resistant mutations in those who are in virologic failure.

This study had several limitations. Firstly, the sample size was small and does not allow for generalisability of findings. Secondly, treatment status was self-report and may not be an exact reflection of lifetime exposure to ART, especially for women who had received PMTCT (although this was probed during the survey) and no data was collected on specific regiments currently or historically used. Unsuppressed viral loads were defined as VL ≥500 copies/ml and not VL ≥400 copies/ml as in previous studies, thus 2 samples were excluded from HIVDR testing.

Our study suggests there may be alarming rates of HIVDR being transmitted between clients or intimate partners and FSWs in Soweto. This will potentially result in a large proportion of treatment naïve FSW having compromised first line therapies. Given the high HIV prevalence in this population and their vulnerability to violence and other health concerns[16, 146], it is critical that we begin to understand transmission dynamics and the outcomes of TDR. In addition, we found that three quarters of FSWs failing treatment had likely developed ADR. This suggests the frequency of treatment interruptions in this population which needs to be better understood for intervention development. Further, routine surveillance of VL must be rigorously undertaken amongst such high-risk populations to ensure that failure to suppress is proactively managed and second line therapies implemented timeously. Given the scale up of the *South African National Sex Worker HIV Plan 2016-2020[59]*, it is important that programmers are aware of the potential for first line resistance, and that more than one quarter of FSW initiated onto treatment and who are in virologic failure, may already have some form of resistance to first line. Furthermore, sex work programs in South Africa currently leverage nurse initiated ART for clinical service provision. Our data highlights the need for greater clinical oversight and understanding within these projects to ensure that resistance concerns

are appropriately monitored and managed. Furthermore, routine HIVDR surveillance amongst key populations should become a priority within South Africa. This will ensure that healthcare officials, policy makers and program implementers are able to monitor and rapidly respond as HIVDR continues to show increasing trends amongst this population.

Table 7-1 Summary of overall study sample

	n (%)
HIV tests done	508
HIV positive	280 (55.1)
Tested for RNA VL	269 (96.1)
VL ≥400 copies/ml	132 (49.1)
Successfully amplified	119 (90.2%)
HIVDR Mutations	45 (37.8)

Table 7-2 Summary characteristics of study sample overall for HIV positive and by VL using a 400 cutoff and drug resistance testing done.

	All HIV+ (n=269)	VL ≥400 copies/ml & DR testing done (n=119)	VL <400 copies/ml (n=141)	p-value
Age (median yrs, IQR)	32 (20-51)	30.9 (29.7-32.1))	34.1 (33.0-35.4)	**0.0001**
CD4 cell count (median, IQR)	473 (311-701)	419.2(371.1-467.2)	623.8(570.2-677.3)	**<0.0001**
VL $\log_{10}$ copies/ml (median, IQR)	2.4(1.6-4.0)	4.2(4.0-4.3)	1.7(1.6-1.7)	n/a
Known Positive	220 (81.8)	85 (71.4)	127 (90.1)	**<0.001**
Treatment Status				
On Treatment (n, %)	118 (43.9)	19 (16.0)	99 (70.2)	-
Treatment Naïve (n, %)	136(50.5)	95(79.8)	34 (24.1)	-
Treatment Defaulting (n, %)	15 (5.6)	5(4.2)	8 (5.7)	-
Detectable resistance (n, %)	45 (16.7)	45 (37.8)	-	-
Wildtype	74 (27.5)	74 (62.2)	-	-
Mutation Type				
NNRTI (n, %)	29 (10.5)	29 (24.4)	-	-
NRTI (n, %)	1 (0.4)	1 (0.9)	-	-
NNRTI+NRTI (n, %)	13 (4.7)	13(10.9)	-	-
NNRTI+NRTI+PI (n, %)	2 (0.7)	2 (1.7)	-	-
Phylogenetic clusters (n)	1 (0.4)	1 (0.9)	-	-

Table 7-3 Summary characteristics of HIV positive FSWs with a VL ≥400copies/ml and drug resistance testing done (n=119), by treatment naïve, on treatment and treatment defaulting.

	Treatment Naive (n=95)	On Treatment (n=19)	Treatment Defaulting (n=5)
Age (median, IQR)	30 (24-36)	35(29-40)	33 (31-34)
CD4 cell count (median, IQR)	381.5 (253-508)	284.5(96-530)	306 (195-526)
VL $\log_{10}$, copies/ml (median, IQR)	4.1(3.3-4.8)	4.0(3.5-4.9)	3.9(3.9-4.1)
Known Positive	61 (64.2)	19 (100)	5 (100)
Wildtype virus	69(93.2)	5(6.8)	0
Resistance Mutations Detected			
Detectable resistance n(%)	26 (27.4)	14 (73.7)	5 (100)
NNRTI n(%)	23 (24.2)	2 (10.5)	4 (80.0)
NRTI n(%)	0	1 (5.3)	0
NNRTI+NRTI n(%)	3 (3.1)	9 (47.4)	1 (20.0)
NNRTI+NRTI+PI n(%)	0	2 (10.5)	0
Phylogenetic clusters	1	0	0

Table 7-4 Mutations by treatment status (>5/45) amongst FSWs with detectable DR in Soweto (n=45), showing n(%)

	HIVDR Mutation	Naïve (n=26)	On treatment (n=14)	Defaulting (n=5)	Total (n=45)
NNRTI MUTATIONS	K103N (n=31)	20(76.9)	7(50.0)	4(80.0)	31(69.0)
	V106M (n=10)	4(20.0)	5(35.7)	1(20.0)	10(22.2)
	P225H (n=4)	-	7(50.0)	1(20.0)	8(17.8)
	Y181C (n=1)	-	1(7.1)	-	1(2.0)
	G190A (n=5)	-	5(35.7)	-	5(11.1)
	K101E (n=6)	4(20.0)	2(14.2)	-	6(13.3)
	Y188L (n=1)	-	1(7.1)	-	1(2.0)
	Y181C (n=1)	-	1(7.1)	-	1(2.0)
	G190A (n=5)	-	5(35.7)	-	5(11.1)
	V179D (n=2)	1(5.0)	1(7.1)	-	2(4.4)
	K101P (n=1)	1(5.0)	-	-	1(2.0)
NRTI MUTATIONS	M184V (n=13)	-	12(85.7)	1(20.0)	13(29.0)
	T215F (n=1)	-	1(7.1)	-	1(2.0)
	K65R (n=4)	1(5.0)	3(21.4)	-	4(8.9)
	K70R (n=1)	-	1(7.1)	-	1(2.0)
	K70E (n=2)	-	2(14.2)	-	2(4.4)
	D67N (n=2)	1(5.0)	1(7.1)	-	2(4.4)
	M41L (n=1)	-	1(7.1)	-	1(2.0)
	V75MI (n=2)	-	2(14.2)	-	2(4.4)
PI	L90M (n=2)	-	2(14.2)	-	2(4.4)

8. CHAPTER EIGHT: UNDERSTANDING THE COMPLEXITIES OF HIV VULNERABILITY AMONGST FEMALE SEX WORKERS IN SOWETO, SOUTH AFRICA.

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Table 8-1 Author Contributions Paper Five

AUTHOR	CONTRIBUTIONS
Jenny Coetzee	Conceptualisation, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, resources, software, software, supervision, validation, visualisation, writing – original draft, writing – review & editing
Minja Milanovich	Conceptualisation, project administration, resources, software, software, supervision, validation, writing – review & editing
Maya Jaffer	Conceptualisation, methodology, writing – review & editing
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8.1 ABSTRACT

Background Despite the high HIV prevalence amongst female sex workers (FSWs) in South Africa, there is a dearth in understanding of the complex interactions between multilevel factors which driver this vulnerability. Previous research has shown the link between violence, mental health and HIV in women from the general population.

Methods This cross-sectional study aims to understand violence and mental health as drivers of vulnerability to HIV for FSWs in Soweto, South Africa. Drawing from a cross sectional study of 508 FSWs, this study presents a structural equation model (SEM) of FSW vulnerability to HIV.

Results Results showed several pathways to HIV, including one from childhood abuse and mediated through exposure to violence. A second pathway between childhood abuse and HIV was mediated by violence experience, PTSD, self-esteem, binge drinking and number of clients. A third pathway was very similar to this, but the mediation was through internalised stigma. There were indirect pathways between number of clients and HIV and between age of entry into SW and HIV. In each case the paths were mediated by internalised stigma, self-esteem, binge drinking and the number of clients.

Conclusion Building on previous research on structural drivers, sexually risky behaviour, violence, mental health and HIV, our study provides strong evidence of the causal pathways among FSW linking their vulnerability to HIV. We have shown the importance of a multi-layered understanding of FSWs' vulnerability to HIV, and the complexity of intersecting pathways. Through developing a more nuanced and complex understanding of vulnerability in key affected populations, we can clearly see the role of mental health and violence as they impact upon the HIV epidemic. It is critical that the South African Government understand that violence and resulting, unaddressed trauma-related needs are likely hampering our HIV prevention and treatment efforts. In addressing violence, it should also be noted that research to understand mechanisms to engage paying and non-paying

partners of SWs needs to urgently be undertaken. The lack of male inclusion in sex work programs is an oversight and inhibits the ability to engage in gender transformative interventions to improve gender equality, a key driver of violence perpetration. Thus, these findings highlight plausible reasons why the current HIV focus is and will continue to fail SWs. These findings support a change in the immediate HIV policy and funder environment with a view beyond the immediate HIV focus and to include strong mental health and violence prevention and treatment interventions as equally important components in the HIV armoury.

8.2. BACKGROUND

South Africa is currently in the process of scaling up service delivery for sex workers (SWs) in line with the South African National Sex Worker HIV Plan 2016-2020 [1]. This, despite the profession being criminalised [2, 3]. The Plan is largely geared to addressing the burgeoning HIV epidemic among SWs, where prevalence ranges from 36% in Cape Town to 89% along major trucking routes [4-6]. HIV prevalence is dependent on various contextual and geographical factors pertinent to the local context of sex work [5]. Given the global focus on HIV, implementation of sex work programmes in South Africa is largely geared towards a biomedical and behavioural approach to HIV prevention and treatment. These overshadow all other health and social concerns this population have, and which if addressed, could be game changers in the HIV prevention armoury. Furthermore, sex work programs in South Africa have limited capacity for the inclusion of male paying or non-paying partners, with projects geared to truckers being the exception. This limits our ability to engage in gender transformative behavioural interventions as a core component of sex work programming in South Africa [7] .

A 2010 longitudinal study highlighted indirect pathways between gender inequality, repeat exposure to gender-based violence, and mental health concerns, sexual behaviour, and ultimately HIV vulnerability amongst women in South Africa [8]. Violence in South Africa, is predicated on

patriarchal notions of male toughness, superiority, and sexual entitlement [9] [8]. Gender-based violence is used as a mechanism to enforce male dominance and control, while punishing female transgressions [10-13][8]. Such relationship inequities result in greater vulnerability to HIV through two mechanisms. Firstly women having less control over their partners to safely negotiate condom usage. Secondly, they have an increased number of sex contacts as they seek emotionally rewarding relationships [8]. Yet little research has been done about these factors and HIV vulnerability amongst FSWs. While overall, HIV prevention agendas are largely dominated by a focus on HIV testing, STI treatment, ART, condom distribution[8] and more recently PrEP for SWs [1], the lack of inclusion of gender issues into such strategies and programs has resulted in limited help being provided to women who are either experiencing violence or in controlling relationships where violence is likely to be an outcome [8]. This includes FSWs who are at the centre of both the HIV and violence epidemics[5, 14-16].

Violence against SWs is a hate crime [14], rooted in discrimination, the criminalisation of the profession, and the aggressive, entitled masculinities to which SWs are exposed [14, 17, 18]. The literature on SW exposure to violence in South Africa, and globally, highlights that not only are they exposed to the same types of violence as other women, but that there is violence specific to sex work, to which they are exposed. Sexual and physical violence at the hands of police and clients has been documented, with studies showing a past year prevalence of between 20-54% in South Africa[6, 19]. A recent study of FSWs in Soweto showed that almost 90% of FSWs had experienced some form of physical or sexual violence in their lifetime, with more than two thirds reporting rape (lifetime)[14]. In South Africa, research shows that the men who purchase sex are more likely to be violent, to have previously raped women, and to engage in risk sexual behaviours [20-22]. Furthermore, violent men are more likely to be HIV positive [23]. Recent evidence shows that violence not only negatively affects adherence [24], but suggests that exposure to such men may fuel HIV drug resistance

amongst sex work populations in Soweto, where treatment naïve FSWs are documented to have sexually acquired HIV drug resistance [16].

Additionally, violence, and the resulting trauma, are strong drivers of mental ill health. One way through which this may happen is the unconscious use of defence mechanisms, geared to managing or avoiding overwhelming feelings of anxiety, shame, and other emotional experiences, while maintaining a positive sense of self [25]. These coping strategies often evolve during childhood, with childhood exposure to violence compounding mental ill health [26]. Childhood exposure to violence can result in physiological changes to the brain, impacting upon emotional stability and relationship formation during adulthood, and in the normalisation of violence [10]. Evidence shows that depression, PTSD and substance abuse are all strongly associated with IPV [27, 28]. The prevalence of depression amongst SWs in South Africa appears to range from 68.7% to 80% [15, 29]. Findings have highlighted that a thirds of FSWs in Soweto suffer from co-morbid symptoms of major depression and PTSD, and that 20% had either had suicide ideations or attempted suicide in the past year. Repeat exposure to violence significantly increased the likelihood of one or more mental health complication by as much as four-times [15]. Binge drinking is commonly associated with SWs in South Africa [5, 6, 15], with alcohol often cited as a coping mechanism for SWs (ref), and as fuelling the violence and HIV epidemics[8]. The link between alcohol consumption and PTSD or depression has also been previously established [26, 30, 31].There are also links between HIV, violence and mental health conditions such as depression, post-traumatic stress disorder (PTSD) and low self-esteem [27, 32-34] (HIV link ref).

Studies have shown that amongst FSWs, HIV vulnerability is driven by a combination of structural, biological and behavioural determinants, factors often beyond the individual level of control. Few studies have considered the complex ways in which the various factors function to create multilevel vulnerability for FSWs [5]. Utilising a dataset which has several previous publications, and shows

that amongst FSWs in Soweto, there is a history of exposure to violence across the lifetime[35] that HIV vulnerability is high [5] and which described the prevalence of mental ill health [36], this paper investigates the complex interactions of bio-psychosocial and structural level factors amongst FSWs in Soweto. Drawing from the model of vulnerability developed by Jewkes et al[8] and seeking to further this work through testing their theory using a structural equation model (SEM) , we hypothesise that violence will drive vulnerability to mental ill-health, which will result in sexually risky behaviours, thus increasing the risk of HIV.

8.3 METHODS

Our cross-sectional study was conducted in Soweto. The locale is predominantly urban and peri-urban, low-income with limited educational and employment opportunities. It has the highest population density in South Africa: an estimated two million inhabitants within >40 suburbs across 61km^2. Eleven apartheid-era former single-sex, and ethnically segregated hostels house an estimated 40,000 residents. A sex work program was launched by the Perinatal HIV Research Unit (PHRU) within the township in October 2013. Their fixed clinic was used as a base for the research [37]. Formative work included cognitive interviews (n=12), and a pilot study (n = 40) [5, 37]. The full methodology has been extensively described in previous research [5].

Inclusion criteria for the main study were: biologically female, over 18 years of age, currently sold sex in Soweto, knew their recruiter, and gave voluntary informed consent to participate. In determining sample size, a two-sided calculation was used to detect a difference between HIV prevalence among FSWs presumed to be violence exposed versus violence unexposed. A sample size of 500 was estimated to ensure sufficient power of analysis·

A respondent-driven sampling (RDS) recruitment strategy was used [38]. The method is a popular way to recruit marginalised populations and to obtaining population-level estimates [39, 40]. A total of 11 seeds (initial participants) were used during the study to recruit 508 FSWs between February

and September 2016. Similar to a chain referral method [39], all participants (including seeds) were given three coupons with which to recruit potential participants. Seeds and subsequently enrolled participants were asked to give the coupons to randomly selected women whom they knew and who knew them, who, like themselves, sold sex in Soweto, and who were older than 18 years. Recruitment chains were mapped between each seed and all subsequent recruits [40, 41].

After screening, participants gave their consent to participate in the study, and then completed a 45-minute, interviewer-administered questionnaire in English, isiZulu or seSotho. Participants were then given a maximum of three uniquely coded coupons and reimbursed R100·00 ($7·69). A further R20·00 ($1·56) secondary incentive for successful recruitment was paid 7–10 days later. Primary reimbursement and secondary incentives were increased five months into the study to cover additional costs to participate[5].

Data were captured directly onto Lenovo tablets using the REDCap electronic data management system [42], hosted by the University of the Witwatersrand, South Africa. The database housed built-in skip patterns, data validation checks, and algorithms. Duplicate data were collected on a convenience sample of 12% of the final sample size with an error rate of 0.6%. Ethical approval was provided by the Human Research Ethics Committee (Medical) of the University of the Witwatersrand, South Africa. The measures used are listed in Table 8-2, below.

Table 8-2: Measures Used

Construct	Indicator	Definition	Measure used	Cronbach Alpha
	HIV status	A dichotomous measure indicating HIV status (negative or positive)	WHO Guidelines [42]	

	Severe binge drinking	A four-item continuous measure: “How often do you have a drink containing alcohol?” (0 “Never”,1 “Monthly Or Less”, 2 “2-4Times Per Month”, 3 “2-3 Times Per Week”, and 4 “4+ Times Per Week”), "How many drinks containing alcohol do you have on a typical day when you are drinking?" (0 “no drinks”, 1 “1 or 2”, 2 “3 or 4”, 3 “5 or 6”, 4 “7 or 9”, and 5 “10 or more”) “How often do you have six or more drinks on one occasion?” (0"Never"1"Less Than Monthly"2"Monthly"3"Weekly"4"Daily Or Almost Daily"), and “How much is a typical drink (0"no drink" 1"250 mls" 2" 440-500 mls" 3"750 mls" 4" 1 litre +")	AUDIT-C [43]	
	Self-esteem Score	A ten-item scale used as a continuous measure. Questions were scored from 3 strongly agree to 0 strongly disagree. “Most of the time I am satisfied with myself”, “At times, I think I am no good at all”, “I feel that I have a number of good qualities”, “I am able to do things as well as most other people”, “I feel I do not have much to be proud of”, “I certainly feel useless at times”, “I feel that I'm a person of worth, at least equal or as good as other people”, “I wish I could have more respect for myself”, “Most of the time I feel as if I am a failure”, and “I take a positive attitude toward myself”. Items 2,5,6,9 were reverse scored.	Rosenberg’s Self Esteem Scale	0.73
	PTSD Score	A, eight-item PTSD scale was used as a continuous measure. Items included: “Recurrent thoughts or memories of the event,” Feelings as though the event is happening again”, “Recurrent nightmares about the event”, “Sudden emotional or physical reactions when reminded of the event”, “Avoiding activities that remind you of the event”, “Avoiding thoughts or feelings associated with the event, so I try not to feel or think about anything that reminds me of it", “Feeling jumpy, get a fright easily”, and “Feeling on guard, ready to fight to protect yourself”	PTSD-8 [44]	
	Internalized Stigma	Eleven measures which included: “Within the past year I have felt ashamed because I am a sex worker?”, “Within the past year I have felt guilty because I am a sex worker? ”, “Within the past year I have blamed myself because I am a sex worker?”, “Within the past year I have felt that I am not worth anything because I am a sex worker?" ”, “Within the past year I have felt punished because I am a sex worker? ”, “Within the past year I have felt suicidal because I am a sex worker?”, “Within the past year I have chosen not to attend a party/bashes because of being a sex worker?”, “Within the past year I have isolated myself from friends and family because of being a sex worker? ”, “Within the past year I have decided to not have (any more) children because of being a sex worker? ”, “Within the past year I have avoided going to the clinic/hospital because of being a sex worker? ”, and “Within the past year I have avoided going to the police because of being a sex worker?”. Items were scored (4"Strongly Agree"3"Agree"2"Disagree"1"Strongly Disagree") and summed to give an overall score of stigma. Higher scores equate to greater levels of internalized stigma.	People Living with HIV Stigma Index [45] adapted	0.70
	Education level	Level of education was asked and dichotomized to indicate incomplete secondary (no primary, primary completed, secondary incomplete), versus secondary schooling completed/post school qualification (secondary school successfully completed, post school qualification)		
	Age first sold sex	Single continuous item asked the age at which sex was first sold: “How old were you when you first sold sex?”		
	Place of Birth	Single item asked about place that individual was born. All South African provinces were listed as well as surrounding countries.		

	Childhood Trauma	Childhood trauma score was derived from the sum of three sub-scales. All questions (n=12) related to events prior to being 18 years of age. Scores ranged between 1, never, to 4, very often. Questions were “I did not have enough to eat”, “I lived in different households at different times”, “I saw or heard by mother beaten by her husband or boyfriend”, “I was told I was lazy or stupid or ugly by someone in my family”, “ Someone touched my thighs, buttocks, breasts or genitals when I did not want him to or made me touch his private parts when I did not want to”, “I was insulted or humiliated by someone in my family in front of other people”, “I was beaten at home with a belt or stick or whip or something else which was hard”, “I had sex with a man who was more than 5 years older than me”, “One or both of my parents were too drunk to take care of me”, “I was beaten so hard at home that it left a mark or bruise”, “I spent time outside the home and none of the adults at home knew where I was”, and “I had sex with someone who was not my boyfriend because I was threatened or frightened or forced". A score of 12 indicated no childhood trauma.	Childhood Trauma Questionnaire (CTQ) [46]	
	Number of Clients	Two items asked about the number of one time clients and the number of regular clients in the past day that sex was sold. These were summed and used as a continuous variable, with the number of clients in the past day being a proxy measure of overall higher or lower volumes of clients, and thus potential historic exposure to HIV.		
Exposure to Violence		A latent construct developed using measures of physical or sexual violence by intimate partners, clients or police in the past 12 months. Experiences of past year discrimination were also included.	WHO violence against women questionnaire [47] and People Living with HIV Stigma Index [45]. Both adapted	
	Discrimination	Seven item measure used continuously. Items scored as 1"Never"2"Once"3"Few Times"4"Often", with overall higher scores indicating greater levels of discrimination experienced and a score of 7 indicated no violence exposure. Questions were: "Within the past year have you been verbally insulted, harassed or threatened because you are a sex worker?", "Within the past year have you been beaten or threatened because you are a sex worker?", "Within the past year have you experienced sexual abuse because you are a sex worker?", "Within the past year have any of your family (partner, children, siblings etc) experienced discrimination as a result of your being a sex worker?", "Within the past year how often have you been forced to change where you live because you are a sex worker?", "Within the past year have you been denied health services because you are a sex worker?", and "Within the past year have you been denied police assistance/ services because you are a sex worker?"	People Living with HIV Stigma Index [45] adapted	0.65
	Intimate Partner Violence	Six questions were asked to assess physical and sexual violence by an intimate partner. Items were scored as 1"Never"2"Once"3"Few"4"Many". Scores were tallied to give a continuous measure with higher scores indicating greater levels of violence experienced and a score of 6 indicated no violence exposure. Questions were: "Within the past year did any partner slap you, push you or throw something at you which could hurt you? ", "Within the past year did any partner hit you with a fist or with something else (such as a beer bottle, stick or belt) which could hurt you? ", Within the past year did any partner kick, drag, beat, choke or burn you?”, "Within the past year did any partner threaten to use or actually use a gun, knife or other weapon against you? ", "Within the past year did any partner physically force you to have sex when you did not want to? ", and "Within the past year did you have sex with any partner when you did not want to because you were afraid of what he might do? "	WHO violence against women questionnaire [47] adapted	

	Police Violence	Six questions were asked to assess physical and sexual violence by police. Items were scored as 1"Never"2"Once"3"Few"4"Many". Scores were tallied to give a continuous measure with higher scores indicating greater levels of violence experienced and a score of 6 indicated no violence exposure. Questions were: "Within the past year did any police slap you, push you or throw something at you which could hurt you? ", "Within the past year did any police hit you with a fist or with something else (such as a beer bottle, stick or belt) which could hurt you? ", Within the past year did any police kick, drag, beat, choke or burn you?", "Within the past year did any police threaten to use or actually use a gun, knife or other weapon against you? ", "Within the past year did any police physically force you to have sex when you did not want to? ", and "Within the past year did you have sex with any police when you did not want to because you were afraid of what he might do? "	WHO violence against women questionnaire [47] adapted
	Client Violence	Six questions were asked to assess physical and sexual violence by a client. Items were scored as 1"Never"2"Once"3"Few"4"Many". Scores were tallied to give a continuous measure with higher scores indicating greater levels of violence experienced and a score of 6 indicated no violence exposure. Questions were: "Within the past year did any client slap you, push you or throw something at you which could hurt you? ", "Within the past year did any client hit you with a fist or with something else (such as a beer bottle, stick or belt) which could hurt you? ", Within the past year did any client kick, drag, beat, choke or burn you?", "Within the past year did any client threaten to use or actually use a gun, knife or other weapon against you? ", "Within the past year did any client physically force you to have sex when you did not want to? ", and "Within the past year did you have sex with any client when you did not want to because you were afraid of what he might do? "	WHO violence against women questionnaire [47] adapted

8.3.1 STATISTICAL ANALYSIS

Univariate and bivariate descriptive statistics and frequencies were determined for categorical and continuous demographic characteristics and risk variables and are presented by HIV status in Table 2. A chi-square test or student t-test of association was used for bivariate analysis using Stata 15[43]. Variables were selected based upon extensive previous analyses [5, 14, 15]. This included both exploratory and confirmatory factor analyses, and multiple logistic or multinomial logistic regressions of factors associated with HIV[5], and mental health concerns[15]. Violence variables have been extensively described [14]. All previous analyses drew from the same dataset used within this analysis with significance being set at ≤ 0.05.

Latent variables were developed and tested using a confirmatory factor analysis. Path analysis were run with candidate variables using the structural equation model (SEM) builder function in Stata 15, to confirm relationships between variables and directionality. All possible variables and paths were

then included in a backward stepwise SEM model building process, where paths were systematically and recursively deleted. Covariates were included based upon the modification indices. In assessing the model goodness of fit, various indices were used. The root mean square error of approximation (RMSEA) [44], the comparative fit index (CFI) [45], and the Tucker-Lewis Index (TLI) [46]. Minimum rules for fit indices were applied. The CFI (0.952), TLI (0.929) and RMSEA (0.031) indicated a strong model fit. Sensitivity analysis were conducted to verify the effect of zero inflation on the PTSD variable. The final model fit was improved but no additional differences between this and the final model were detected. There was no missing data (n=508).

8.4 RESULTS:

The median age of FSWs in Soweto was 30 years, with only 16 cross-border migrants (Table 8-3). More than half were Zulu speaking (53.9%) and the remainder were SeSotho speaking or spoke other languages (25.8% and 20.3%, respectively). The majority of FSWs had an incomplete education (384, 75.6%), had sold sex for the first time at age 25 (6-48), and were born in Gauteng (346, 68.1%). The median score for childhood trauma was 18 (12-34) and 56.9% had had more than 5 clients the last day that they had sold sex (n=289). More than half (280, 55.3%) were HIV positive. Overall, three quarters (381, 75.1%) engaged in binge drinking, with the median score being 10 (0-17). Self esteem scored were all in the low to moderate categories (211, 42.6% and 296, 58.4%, respectively), with the median being 11 (3-19), and more than one-third of FSWs had symptoms indicative of PTSD (per the DMS-IV diagnostic criteria), with a median PTSD score of 18 (8-31). Internalised stigma was reported by 72.6% (369) of FSWs, and the median was 14 (8-25), while 68.5% (348) experienced discrimination, with a median score of 9 (7-25). Past year intimate partner violence was reported by 56.7% (n=288, MED, IQR 12, 8-33), past year police violence was reported by 10.4% (n=53, MED, IQR 4, 4-13), and past year client violence was reported by 52.2% (n=265, MED, IQR 5, 4-16).

Table 8-3 also shows that HIV status was associated with higher binge drinking scores (8.8, 95% CI 8.3-9.4, p=0.05), a moderate-low self-esteem score (11.1, 95% CI 10.7-11.5, p= 0.06), and more experiences of discrimination (9.3, 95% CI 9.0-9.6, p=0.016). Experience of police and client violence was associated with being HIV positive (4.3, 95% CI 4.2-4.4, p=0.024, and 6.1, 95% CI 5.7-6.4, p=0.056, respectively) as compared with HIV negative. Almost two-thirds of FSWs with an incomplete education were HIV positive (234, 60.9%, p=<0.0001) when compared to HIV negative, where 40% had an incomplete education (150, p=<0.0001). The median age of first selling sex was older amongst HIV positive FSWs than HIV negative FSWs (26.5, 95% CI 25.7-27.3 versus 24.3, 95% CI 23.4-25.2, p=0.0002). There were more HIV positive FSWs who were born outside of Gauteng Province as compared with HIV negative FSWs born outside of the province (108, 38.5% versus 54, 23.7%, p=<0.0001). Childhood trauma scores were higher amongst FSWs who were HIV positive as compared to those who were negative (p=0.0041), and 61.8% of HIV positive FSWs had more than 5 clients in the last working day (173, p=0.014) compared with 49% of HIV negative FSWs.

As shown in Table 8-4 and Figure 8-11, the model has 5 exogenous variables and four of the five had direct pathways to HIV. These four were increasing age of entry into sex work, (incomplete) education, being born outside of the Gauteng Province (and having more than 5 clients per day. Three pathways connected child abuse and HIV, all mediated by violence exposure. The first had a single mediating variable, which was a latent variable for violence exposure, in the path between childhood abuse experience and HIV, such that women with higher levels of childhood abuse had a greater vulnerability to violence by intimate partners, client or police, or discrimination, leading to a greater likelihood of being HIV positive. The second pathway between childhood abuse and HIV was mediated by violence experience, PTSD, self-esteem, binge drinking and number of clients. A third pathway was very similar to this, but instead of being mediated by PTSD, this was mediated by internalized stigma. There were indirect pathways between number of clients and HIV and between

age of entry into SW and HIV. In each case the paths were mediated by internalised stigma, self-esteem, binge drinking and the number of clients.

8.5 DISCUSSION:

In this study we show multiple pathways to HIV for FSWs in Soweto. Structural drivers of risk amongst these women, had simple and direct pathways. Violence mediated three pathways to HIV, all beginning in exposure to childhood abuse. The pathway from childhood abuse, through violence, then to mental health factors and leading to sexual risk behaviours resulting in HIV were the strongest. Importantly, out findings are in line with the model developed by Jewkes et al. [8], showing the importance of violence and mental ill health in HIV vulnerability.

The model had four indirect paths to HIV that were mediated by variables which measured aspects of mental health, substance use and the well-being of FSWs. These variables were PTSD, internalised stigma, self-esteem and binge drinking. The paths mediated by these mental health factors originated in child abuse, age of entry into sex work and the number of clients (which also formed part of the pathway). There was a common order to the mediating variables from self-esteem through binge drinking, to number of clients and HIV. The variable in the paths prior to this were either internalised stigma or, in the child abuse/violence pathway, PTSD. This is largely consistent with previous models on the role of psychological distress amongst women, where the relationship between violence and HIV was mediated by mental ill health [8]. Interestingly, the self-esteem variable operated in such a way that higher self-esteem was related to greater risk. All of the FSWs scored in the low-moderate range of self-esteem, suggesting considerable underlying psychological distress [15]. Evidence shows that there are overall low levels of self-esteem amongst FSWs in Soweto. Interestingly, higher levels of self-esteem (although still relatively low) were likely indicative of a coping strategy masking their distress [15]. Through unconscious defence mechanisms, it is likely that they are attempting to avoid or manage overwhelming feelings of anxiety, shame, or other

emotional experiences associated with engaging in sex work, while maintaining their self-esteem [25]. Thus, our model suggests that greater levels of internalised stigma contributes to more primitive, manic defence mechanisms measured here through higher self-esteem. This distress results in greater levels of binge drinking. Heavy drinking functions both to hide the pain of engaging in highly discriminated against and stigmatised sexual encounters (selling sex), and facilitates the context for meeting larger numbers of clients, and thereby drives HIV risk. Finally, our study shows the cyclical nature of mental health and behavioural factors, with greater numbers of clients leading to more internalised stigma, which has a pathway back to greater numbers of clients, through self-esteem, and binge drinking, finally resulting in HIV. Thus, building on previous research from the general population which postulated a model of vulnerability inclusive of violence, mental health and HIV[8], our study shows that HIV vulnerability amongst SWs functions through causal pathways connecting violence, mental health related issues and risky sexual behaviours.

Our findings suggest a continuum of vulnerability from childhood into adulthood for FSWs in Soweto. In considering the model of vulnerability presented in conjunction with the current rollout of programs for SWs in South Africa, it is clear that the focus of HIV prevention has remained at the tail end of the vulnerability continuum, focusing on biomedical and behaviour modification interventions. Our study shows the importance of building a stronger evidence-base for intervention development. Little is known about how to prevent violence amongst FSWs in South Africa, and there is limited evidence on how to address the complex mental health needs of this populations given their ongoing exposure to violence. Given the scaling up of a National Sex Work HIV Plan, it is important that such questions are posed and that future research into HIV prevention interventions address violence prevention, stigma and discrimination, and mental ill health as key drivers of the epidemic. Given findings showing the high rates of HIV drug resistance amongst this population and suggestive of adherence concerns[47], it is vital that we begin to understand HIV treatment in line with factors beyond the current biomedical and behavioural interventions. When considering that

FSWs often have more immediate concerns than HIV [5], the importance of understanding mechanisms to address the full scope of their vulnerability becomes apparent.

Our findings show extremely prevalence of violence, and this is often driven by discrimination against the SWs. Both experiences of discrimination and internalised stigma were fundamental components of HIV vulnerability, and this model further confirms previous findings that violence against sex workers is a hate crime[14]. Given that SWs are exposed to aggressive forms of masculinity, and that violence against them is rooted in discrimination against the profession, legislative frameworks which criminalise the profession urgently require revision. Furthermore, and as decriminalisation is likely to be a long-term solution, mechanisms to make SW safer for the persons engaging, need to be understood and interventions developed which can be implemented in the interim.

This study had several limitations. As this study draws from a small sample of FSWs in Soweto, generalisability should be interpreted with caution. Despite drawing from an RDS dataset, weighted data was not included within this study due to the limitations of presently available RDS software. Importantly, we were unable to explore gender equality. The data is cross sectional, limiting our understanding of temporality, particularly the timing of the HIV infection. However, measures were used which in themselves refer to different time periods across the lifetime and as such are able to address some issues of temporal sequencing.

Building on previous research on structural drivers, sexually risky behaviour, violence, mental health and HIV, our study provides strong evidence of the causal pathways among FSW linking their vulnerability to HIV. We have shown the importance of a multi-layered understanding of FSWs' vulnerability to HIV, and the complexity of intersecting pathways. The South African National Sex Work HIV Plan is underpinned by a biomedical and behavioural foci on HIV prevention with limited scope to drive mental health and violence as key components of SW vulnerability to HIV. This

means that in terms of a vulnerability continuum, the focus of interventions is being placed at the tail end of vulnerability rather than earlier in the continuum, which would likely yield more sustainable results. This highlights the urgent need to diversify service offerings to meet the needs of the population rather than focus largely on sexual risk behaviours and treatment options for HIV prevention. Without more complex understandings of HIV vulnerability, it is impossible to fully appreciate the policy and practice interventions required. Thus South Africa will continue its burgeoning HIV epidemic and our prevention and treatment interventions are likely to have limited effect. Through developing a more nuanced and complex understanding of vulnerability in key affected populations, we can clearly see the role of mental health and violence as they impact upon the HIV epidemic. It is critical that the South African Government understand that violence and resulting, unaddressed trauma-related needs are likely hampering our HIV prevention and treatment efforts [16, 24]. In addressing violence, it should also be noted that research to understand mechanisms to engage paying and non-paying partners of SWs needs to urgently be undertaken. The lack of male inclusion in sex work programs is an oversight and inhibits the ability to engage in gender transformative interventions to improve gender equality, a key driver of violence perpetration [7]. Thus, these findings highlight plausible reasons why the current HIV focus is and will continue to fail SWs. These findings support a change in the immediate HIV policy and funder environment with a view beyond the immediate HIV focus and to include strong mental health and violence prevention and treatment interventions as equally important components in the HIV armoury.

Table 8-3: Demographic characteristics and bivariate analysis showing risk factors associated with HIV status for FSWs in Soweto

(n=508)	Overall	HIV Negative (44.9%)	HIV Positive (55.1%)	p-value
Age	30(18-59)	-	-	-
Migrant Status				
South African	488(96.8)	-	-	-
Non-South African	16(3.2)	-	-	-
Home language				
Zulu	274 (53.9)	-	-	-
Sotho	131 (25.8)	-	-	-
Other	103 (20.3)	-	-	-
HIV Status				
HIV Negative	228 (44.9)	-	-	-
HIV Positive	280 (55.1)	-	-	-
Severe binge drinking	10 (0-17)	8.0(7.4-8.6)	8.8(8.3-9.4)	**0.05**
Self-esteem Score	11(3-19)	10.6(10.2-11.0)	11.1(10.7-11.5)	**0.06**
Low	211(42.6)	105(46.3)	106(37.9)	
Moderate	296(58.4)	122(53.7)	174(62.14)	**0.06**
PTSD Score	18(8-31)	16.7(15.9-17.5)	16.5(15.7-17.2)	0.67
Internalized Stigma	14(8-25)	14.5(14.1-14.8)	14.6(14.3-15.0)	0.52
Discrimination	9(7-25)	8.8(8.5-9.1)	9.3(9.0-9.6)	**0.016**
Intimate Partner Violence	12(8-33)	13.6(12.8-14.4)	13.7(12.9-14.9)	0.89
Police Violence	4(4-13)	4.1(4.0-4.2)	4.3(4.2-4.4)	**0.024**
Client Violence	5(4-16)	5.6(5.3-5.9)	6.1(5.7-6.4)	**0.056**
Education level				
Incomplete schooling	384 (75.6)	150 (39.1)	234 (60.9)	
Secondary complete/some tertiary	124 (24.4)	78 (62.9)	46 (37.1)	**<0.0001**
Age first sold sex	25(6-48)	24.3(23.4-25.2)	26.5(25.7-27.3)	**0.0002**
Place of Birth				
Gauteng	346 (68.1)	174(76.3)	172(61.4)	
Other (includes cross-border migrants)	162 (31.9)	54(23.7)	108(38.6)	**<0.0001**
Childhood Trauma	18 (12-34)	18.4(17.9-18.9)	19.5(19.0-20.0)	**0.0041**
Number of Clients				
<4 clients / day	219(43.1)	112(49.1)	107(38.2)	
≥5 clients per day	289(56.9)	116(50.9)	173(61.8)	**0.014**

Figure 8-1: Structural equation model showing direct and mediated relationships to HIV amongst female sex workers in Soweto.

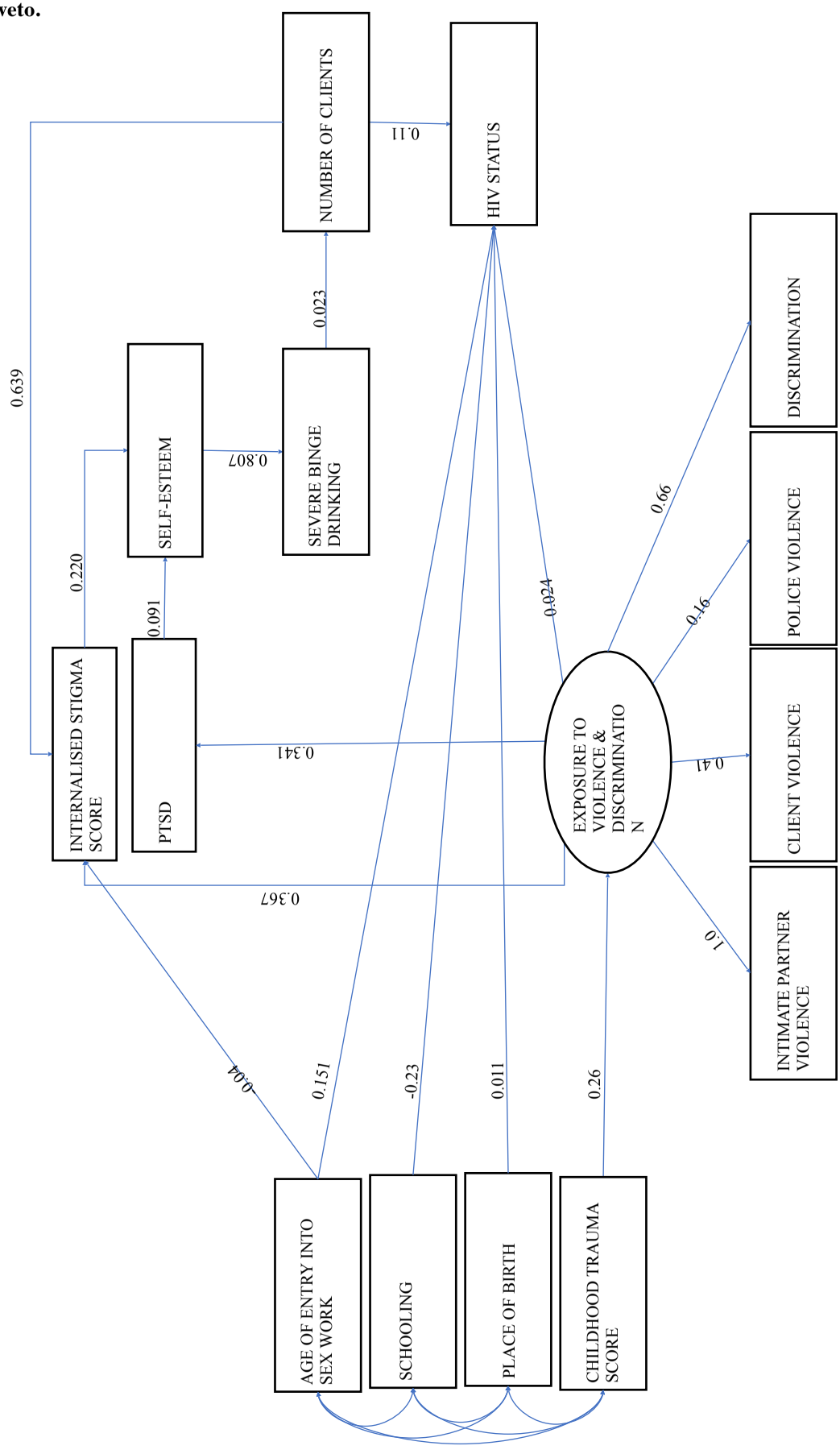

Table 8-4: Female sex worker HIV vulnerability model: Direct effects, disturbance variances, and equation-level goodness of fit

Parameter						
Direct Effects	**Standardized Coefficient**	**Std. Error**	**z**	**p-value**	**95% Confidence Interval**	
Number of Clients → HIV status	0.108	0.042	2.56	**0.01**	0.025	0.191
Violence Exposure → HIV status	0.024	0.009	2.53	**0.011**	0.005	0.043
Age first sold sex → HIV status	0.151	0.044	3.37	**0.001**	0.063	0.239
Place of Birth → HIV status	0.011	0.003	3.54	**<0.0001**	0.004	0.017
Education level → HIV status	-0.23	0.048	-4.79	**<0.0001**	-0.32	-0.13
Number of Clients → Internalized Stigma	0.639	0.259	2.47	**0.014**	0.131	1.146
Violence Exposure → Internalized Stigma	0.367	0.070	5.18	**<0.0001**	0.228	0.506
Age first sold sex → Internalized Stigma	-0.04	0.018	-2.4	**0.016**	-0.08	-0.00
Severe binge drinking → Number of Clients	0.023	0.004	4.98	**<0.0001**	0.014	0.032
Self-esteem Score → Severe binge drinking	0.807	0.356	2.26	**0.024**	0.108	1.506
PTSD Score → Self-esteem Score	0.091	0.022	4.07	**<0.0001**	0.047	0.136
Internalized Stigma → Self-esteem Score	0.220	0.047	4.65	**<0.0001**	0.127	0.313
Violence Exposure → PTSD Score	0.341	0.147	2.31	**0.021**	0.051	0.631

Disturbance variances	**Estimate**	**SE**	**[95% Conf. Interval]**	
HIV status	0.218	0.013	0.193	0.247
Internalized Stigma	7.415	0.500	6.496	8.464
Number of Clients	0.231	0.014	0.204	0.262
PTSD Score	38.43	2.465	33.89	43.58
Self-esteem Score	9.968	0.627	8.811	11.27
Severe binge drinking	25.41	5.075	17.17	37.58
Discrimination	2.715	0.337	2.128	3.464
Intimate Partner Violence	28.35	2.032	24.63	32.63
Police Violence	0.504	0.039	0.432	0.588
Client Violence	4.738	0.341	4.114	5.456
Violence Exposure	6.266	1.412	4.027	9.748

Place of Birth	0.216	0.013	0.191	0.244
Age first sold sex	44.86	2.823	39.66	50.75
Education level	0.184	0.011	0.162	0.208
Childhood Trauma	16.80	1.057	14.85	19.01

Equation-level goodness of fit	**r-squared**
HIV status	0.117
Internalized Stigma	0.142
Number of Clients	0.051
PTSD Score	0.021
Self-esteem Score	0.066
Severe binge drinking	-0.18
Discrimination	0.517
Intimate Partner Violence	0.205
Police Violence	0.287
Client Violence	0.201

9. CHAPTER NINE: INTEGRATED NARRATIVE: DISCUSSION OF FINDINGS , IMPLICATIONS FOR SEX WORKER INTERVENTION DEVELOPMENT AND CONCLUSIONS

This thesis contributes to the literature on understanding factors associated with HIV infection amongst FSWs in Soweto, South Africa, in order to inform the development of future interventions targeting this population. Overall, the findings from this study contribute in novel and informative ways to our understanding of the complexities of HIV vulnerability. The findings, while being congruent with previous studies on SWs, highlight the need for more complex analyses of data to ensure that our understanding of vulnerability, and thus intervention development, intersects with HIV, violence, and mental health needs. This thesis contributes new knowledge to a) the prevalence and perpetration of violence against SWs, and the co-occurrences thereof (Chapter 4); b) the mental health needs of this population (Chapter 5); c) HIV prevalence specific to the Soweto SW context (Chapter 6); d) an understanding of drug resistance in this population and the possibility of sexually acquired HIVDR (Chapter 7); and e) and an overarching, theoretically based model showing the intersections between violence, mental health and HIV vulnerability (Chapter 8). The findings presented in Chapters 4 through 8, as manuscripts either accepted for publication or under review, contribute to our understanding of factors affecting FSWs, in terms of their HIV vulnerability and their exposure to violence and mental health concerns. They also build on previous models of vulnerability for women in South Africa and globally, adding to the body of evidence highlighting the complex interactions between these three issues.

In further discussing these, this chapter will begin by giving an overview of the main findings from each chapter (4-8), and their relevance to gaps identified in the literature. A discussion of the broader implications of the findings will then be undertaken, drawing from the knowledge generated in each chapter as it speaks to the entire body of work included in this thesis. Learnings from the development and implementation of a strongly community participatory body of work will be reflected upon, as will the limitations of this research, with suggestions being made for future research needed to be undertaken. Finally, the chapter will end with conclusions and recommendations based upon the body of work completed within this thesis.

9.1. CONTRIBUTIONS TO THE LITERATURE

The high HIV prevalence amongst SWs in South Africa is of real concern, both for the persons infected and affected by the epidemic, and for its unabated growth in South Africa. Our findings highlight the extreme vulnerability of FSWs to HIV, with the risk thereof being heightened through exposure to violence and mental health. Of particular concern, there was also evidence of both transmitted and acquired HIVDR. As seen below, and in table 9-1, this thesis forms a substantive addition to the literature on FSW both in Soweto, South Africa and to global knowledge bases.

In Soweto, FSWs are exposed to high rates of violence in multiple forms across their lifetime. Our findings show that violence continues unabated into adulthood at levels far higher than in the general population and overall at higher levels than previously documented amongst SWs in South Africa. We argue that violence against FSWs is rooted in discrimination and as such is a hate crime (Chapter 4).

Secondly, our findings highlight the burden of vulnerability to treatable mental health conditions for FSWs in Soweto. More than two-thirds of FSWs were suffering from high depression symptomology, more than a third from PTSD, and comorbidity between the two conditions was

prevalent in more than a third of the women engaging in sex work in Soweto. Our findings also confirmed the important role of violence in mental ill health amongst FSWs (Chapter 5).

Thirdly, this thesis shows a population level HIV prevalence of 53.1% amongst FSWs in Soweto. Advancing age, limited education and multiple clients were all risk factors associated with HIV. Thus, findings suggested that HIV vulnerability was strongly driven by a combination of structural, biological and behavioural determinants. While describing a hitherto largely undocumented population of FSWs, our findings confirm the urgent need to scale up innovative HIV prevention and treatment programs for this population When compared to previous studies of FSWs in South Africa, the evidence shows the importance of tailoring interventions to the varying profiles of sex work populations in the country (Chapter 6).

Fourthly, more than one third (45/119) of the genotyped sample had HIVDR, with resistance to the NNRTI class being the most common. Almost half of HIV positive FSWs had unsuppressed viral loads, increasing the likelihood for onward transmission of HIV. Disturbingly, more than one in four treatment naïve women who had a viral load ≥400, had HIVDR. This suggested the possible sexual transmission of HIVDR across the sex work sector, plausibly affecting SWs, their clients and intimate partners. Given the high burden of HIVDR in a population with a high background prevalence of HIV, it is imperative that routine monitoring of HIVDR be implemented. Understanding transmission dynamics of HIVDR in FSW and its impact on treatment success should be urgently elucidated (Chapter 7).

Lastly, and a critical component in understanding the overall body of work, are the findings that pathways to HIV vulnerability are mediated by both violence and mental health concerns. Building on previous research on structural drivers, sexually risky behaviour, violence, mental health and HIV, our study provides strong evidence of the causal pathways among FSW linking their vulnerability to HIV. We have shown the importance of a multi-layered understanding of FSWs' vulnerability to HIV,

and the complexity of intersecting pathways. Through developing a more nuanced and complex understanding of vulnerability in key affected populations, we can clearly see the role of mental health and violence as they impact upon the HIV epidemic. It is critical that the South African Government understand that violence and resulting, unaddressed trauma-related needs are likely hampering our HIV prevention and treatment efforts. In addressing violence, it should also be noted that research to understand mechanisms to engage paying and non-paying partners of SWs needs to urgently be undertaken. The lack of male inclusion in sex work programs is an oversight and inhibits the ability to engage in gender transformative interventions to improve gender equality, a key driver of violence perpetration. Thus, these findings highlight plausible reasons why the current HIV focus is and will continue to fail SWs. These findings support a change in the immediate HIV policy and funder environment with a view beyond the immediate HIV focus and to include strong mental health and violence prevention and treatment interventions as equally important components in the HIV armory (Chapter 8). Below, the gaps in the literature and related findings from this thesis, are summarized in Table 9-1.

Table 9-1: Summary of gaps in the literature and findings in this thesis that contribute to the sex worker HIV research evidence

TOPIC	GAPS TO BE ADDRESSED IN THIS THESIS	SUMMARY MAIN FINDINGS
A description of violence by perpetrator and violence type	- Violence is not well explored within SW literature. - There are insufficient details on perpetrator type, and the types of violence which they perpetrate. - There is limited knowledge on the childhood exposure to trauma amongst FSWs in South Africa. - Lifetime exposure to sexual violence is not well defined for SW populations in South Africa - The co-occurrence of violence amongst this population has not been previously considered	- We describe exposure to violence by intimate partners, clients and police for both the past year and ever, amongst FSWs in Soweto. Our findings show that past year levels of violence are extremely high with more than half being exposed to IPV, and almost half experiencing physical or sexual violence by a client. - Lifetime exposure to violence for FSWs in Soweto is extremely high, with only 14.4% reporting no violence exposure. Intimate partner violence was the most likely form of violence to co-occur. - Exposure to violence during childhood, when dichotomised as none/a few versus frequently/very often, was consistent with findings for the general population. However, exposure to sexual abuse was substantially high (44.3% versus 35.4%) - Lifetime prevalence of sexual assault was 62.4%. - Violence exposure was strongly significantly associated with discrimination, suggesting that violence against FSWs is a hate crime.
Depression and post-traumatic stress amongst FSWs in Soweto	- Mental health needs of sex workers are not well understood locally. - There is no available data on the impact of violence upon the mental health needs of FSWs in South Africa	- Findings show a high prevalence of mental health concerns, with 38.4% suffering from either depression or PTSD, and 32.7% from both depression and PTSD. Overall, 68.7% of FSWs in Soweto have symptoms of major depression. - The co-occurrence of violence was shown to increase the risk of mental health complications by as much as 4 times as compared with no violence exposure.

TOPIC	GAPS TO BE ADDRESSED IN THIS THESIS	SUMMARY MAIN FINDINGS
Factors associated with HIV infection	- No study has previously estimated the HIV prevalence of FSWs in Soweto. - The literature of sexual risk factors is limited in its reflective ability to understand factors such as condom negotiation - It is not understood what economic or social factors are most important to FSWs vulnerability to HIV in Soweto	- More than half of FSWs in Soweto were HIV infected. The HIV prevalence of FSWs in Soweto was lower than previously described for FSWs in Johannesburg, South Africa (53.6% versus 71.3%). - A variable was generated to understand consistency of condom use which was more complex in its development, and potentially allowed for an improved estimator of consistent condom use over the previous month. - Education and being born outside of the Gauteng Province, wherein Soweto is located, were both found to be strongly associated with an increased likelihood of being HIV positive. An intimate partner knowing that she sold sex was also significantly associated with being HIV positive.
Viral suppression and drug resistance amongst FSWs in Soweto	- There is a dearth of evidence on VL and HIVDR amongst SW in South Africa	- Overall, 16% of HIV positive FSWs had HIVDR. Of those who had viral loads greater than 400, and who were treatment naïve, almost 40% had transmitted HIVDR, suggesting the possible sexual acquisition thereof. Three quarters of FSWs who reported adhering to their treatment but were in virologic failure appeared to have acquired HIVDR.
Modelling the intersections between HIV, violence and mental health amongst FSWs in South Africa	- HIV vulnerability FSWs has previously been considered in terms of linear relationships, which has not enabled a more complex understanding of the intersections between violence, mental health and HIV vulnerability - Previous studies of the general population have suggested the link between HIV, mental health and violence, however the data was not included within one overarching statistical model	- There were multiple pathways to HIV for FSWs in Soweto. Pathways to HIV vulnerability were complex and were mediated by both violence and mental health needs, which led to increased sexual risk behaviours resulting in HIV. - Building on previous research on structural drivers, sexually risky behaviour, violence, mental health and HIV, our study provides strong evidence of the causal pathways among FSW linking their vulnerability to HIV. - The model had four indirect paths to HIV that were mediated by variables which measured aspects of mental health, substance use and the well-being of FSWs - Findings suggest a continuum of vulnerability from childhood into adulthood for FSWs in Soweto

This study describes a previously undocumented subset of FSWs who are based within Soweto, an urban African township on the outskirts of Johannesburg, Gauteng[2, 146, 202, 265, 278]. Contrary to former accounts in the literature [11, 126, 268], FSWs in Soweto work largely in taverns or informal drinking establishments, and hostels. The women are often entering into sex work in the mid-twenties, having already born children. Their reasons for entering sex work centre on money and basic survival. While transactional-sex relationships in Soweto have been described previously [10, 26], our study highlights the impoverished nature of FSWs in Soweto, many of whom enter the sex work industry as a means of survival.

9.2. VIOLENCE

The body of work undertaken for this thesis addresses multilevel vulnerability for FSWs in Soweto. Violence forms a core component of this, and is a key driver of both mental health needs and of HIV vulnerability. The study shows the disparate vulnerability of FSWs in Soweto to violence by multiple partner categories and across the lifetime of these women. Almost 90% of FSWs reported exposure to violence in their lifetime, highlighting their immense vulnerability. Lifetime likelihood of experiencing sexual assault was 2.6 times higher than the prevalence reported for women in the general population of Gauteng (62.4% versus 23.5%) [132] and suggests an overwhelming exposure to rape and other forms of sexual violence for FSWs in Soweto. Childhood sexual violence exposure was higher amongst FSWs as compared to the general population in South Africa (44.3% vs 35.4%) [279]. This is consistent with previous findings that childhood sexual assault is higher amongst SWs [280]. Together these findings suggest that engaging in sex work is a key aspect of vulnerability to the high levels of violence in adulthood, in particular sexual violence, and denotes the relationship inequalities which exist between FSWs and their partners (both paying and non-paying).

The study showed a higher prevalence of violence by type, as compared to other studies of violence exposure in FSWs. Sexual violence in the preceding year was almost 50% higher than that recorded

in the SAHMS (30.4% vs 21.9%). This was to be expected given the depth of questioning within our study. The findings also showed the prevalence of IPV to be similar to those from a 2015 study on violence against substance abusing SWs [139]. The study highlights that the unabated continuation of violence into adulthood for FSWs, has resulted in two-thirds of them experiencing a sexual assault with more than three quarters being exposed to other forms of violence across their lifetime. The comprehensive nature of this study in understanding the prevalence of violence (past year and lifetime), shows the importance of including measures which ask about violence by different perpetrator types to ensure that accurate estimations can be made of the prevalence of violence, which appears to be higher than previously thought. This is unsurprising given the aggressive masculinities prevalent in South Africa, that SWs transgress a multitude of social norms, and that sex is paid for, thus SWs are positioned as a commoditised and dehumanised population. Their relationships with intimate partners, clients and the police are prone to being inequitable, with physical and sexual violence against SWs possibly being perceived by the perpetrators as a "justifiable violence". Thus, there are higher levels of violence perpetrated against FSWs than women in the general population

In considering violence by perpetrator category, it was found that prevalence varied between this and other research. Exposure to intimate partner physical violence was lower in our study as compared with that found amongst substance abusing SWs (48.6% vs. 63.3%)[139]. When compared to a study of Kenyan SWs [147], the findings showed a substantially lower prevalence of IPV (53.8% vs 79%). However, the findings on intimate partner rape were consistent with previous research (20.4% vs. 19%). Client violence in the past year was higher in this study than in other studies with almost half of Sowetan FSWs having experienced physical or sexual violence (46.8%) compared with 37% and 20% of street- and brothel-based SWs in Cape Town. Furthermore, there was only a small variation between past year and lifetime exposure to violence by perpetrators. This highlights the consistency

of violence exposure for FSWs. The fact that hat violence perpetration is often done with impunity in South Africa functions to drive this epidemic.

One of the major findings of this study was describing the co-occurrence of violence amongst FSWs, which was substantially higher than has been found in women in the general population. More than 50% of polyvictimization involved IPV, which has not previously been highlighted as a major area of concern amongst SW populations in South Africa, where violence against SWs was assumed to be perpetrated largely by police and clients. That discrimination was strongly associated with the co-occurrence of violence provides important information on the nature of violence against FSWs. This suggest that violence against FSWs is a systematic, work-related discrimination, making it a hate crime. The men who purchase sex are more likely to engage in other violent and criminal activities [150], resulting in an inherent vulnerability for FSWs to violent partners, both clients and intimate. Furthermore, hostilities towards SWs are often grounded in moral ideologies surrounding gender normative behaviours which SWs transgress. Perpetrators of violence against SWs are infrequently held accountable. This is underpinned by a legislative framework criminalising SW in South Africa, which enables unlawful and criminal actions against SWs, by policing officials. Violence by police against SWs in South Africa has been well documented[100, 158, 160, 184], and while our study shows lower levels than previous recorded amongst SWs in South Africa, it nonetheless adds to a growing body of evidence highlighting police violence and their brutal treatment of SWs.

9.3. MENTAL HEALTH

In addition to the findings on violence, this study demonstrated the significant burden of mental illness amongst FSW, with more than two thirds of FSWs in Soweto suffering from symptoms suggestive of severe depression, and more than a third from PTSD. We highlight their high comorbidity in this population, and the high prevalence of suicidality. In addition, we show that almost three quarters of FSWs had internalised feelings of shame and guilt surrounding their

engagement in sex work increasing the likelihood of mental health symptoms. We found low levels of self-esteem amongst FSWs, but, interestingly higher levels of self-esteem were associated with more mental health problems. Critically, our study showed the impact of repeated exposures to violence on mental health.

Our findings highlight the high prevalence of depression and PTSD amongst FSWs who are marginalised and often discriminated against due to their work[146]. Overall there is a far higher vulnerability to mental health concerns within this subset of the population where the prevalence of PTSD were double those of the general South African adult population (39.6% vs 16.5%)[180]. Our PTSD rates were higher than in studies of FSWs in Australia and Israel (31% and 17%, respectively) [249, 250]. The prevalence of depression was also higher than those documented in the general adult population of South Africa, where only 4.9% suffer from depression[203]. While the prevalence of depression in our study was slightly lower than that recorded amongst SWs in KwaZulu Natal (66.3% versus 78.4%)[201], we note that the KwaZulu Natal study drew from a subset of SWs who were already attending a support group which may have biased the sample. Our findings are almost 10% higher than those found amongst young women in an informal settlement in South Africa[251]. While being 10-30% higher than those documented amongst FSWs across studies[247] [249, 250] they are substantially lower than the prevalence of depression found amongst Nepalese SWs[248]. Overall, our findings highlight the need to integrate effective mental health screening and interventions within existing programs which target SWs.

Exposure to violence was most strongly associated with both depression and PTSD. Previous research has shown the vulnerability of FSWs in Soweto to high levels of violence throughout their lifetime[202], and this study confirms the impact which repeat occurrences of trauma have on these women, in particular comorbid depression and PTSD. When compared to rape survivors in the general population, the current study shows that PTSD and depression amongst FSWs is extremely

high[208, 209], as is their risk of sexual violence as shown in previous findings from the same population[202]. Previous research has shown far greater levels of poly-victimisation and past year exposure to violence amongst FSWs than in the general population[202]. Interestingly, exposure to childhood violence was not directly associated with mental health complications, which requires further investigation. Our findings show the need for strategies to reduce the prevalence of gender based violence (GBV) in South Africa while strengthening psychosocial support services. This will be of importance for FSWs who have limited access to mental health services and are currently the focus of intensive HIV treatment and prevention campaigns. The established link between mental health and adherence to medication[194] should serve as strong encouragement for policy makers and implementers alike to ensure that a strong set of preventative interventions to stop violence exposure are implemented alongside comprehensive mental health services.

Our study found a very high rate of internalised stigma and a strong association between how women saw themselves as SWs which both complicated and was complicated by their mental health. Internalised stigma results in avoidance of health services, increasing the risk of health complications[202]. Approaches to healthcare access which are cognisant of the mental health needs of this population, and which are more holistic in nature, are important to meeting the overall needs of the population. The criminalisation of sex work has been documented to force SWs to conceal their identities[201], with negative social views creating a sense of isolation, as well as discrimination enacted by family, community and public protectors such as health and policing officials[202]. Legislative frameworks and policies which contradict South Africa's Constitution, and further the vulnerability of FSWs are stifling their mental health, and must be revised.

Our study found overall low levels of self-esteem amongst FSWs. The normal range for self-esteem scores is from 0-30. Our median score was 11(9-13), suggesting that FSWs in Soweto have low to moderate-low self-esteem. We found strong associations between increasing levels of self-esteem,

and both depression and PTSD. Our findings suggest that while self-esteem is low, moderate-low levels may be masking greater levels of psychological distress, measured through depression and PTSD. This suggests that there are possibly psychic coping strategies being employed by FSWs which may present at a slightly higher self-esteem. More research is needed to understand the complex mental health challenges which FSWs face and psychological responses.

The high levels of overall binge drinking found amongst FSWs[16], and finding that more than 50% of the population engage in severe and frequent binge drinking, shows that alcohol is plausibly used as a coping mechanism in sex work despite its lack of association with either mental health outcomes. Further research is required in order to understand the link between mental health concerns and alcohol consumption in this population. Current SW health strategies reflect on the need for substance abuse interventions, yet South Africa has inadequate rehabilitation services for the general population, let alone a key population.

9.4. HIV

We found immense vulnerability among FSWs to HIV, with 53.6% infected overall. Structural factors, including the lack of completed education, and migrancy were strongly associated with HIV. Other factors strongly associated with HIV were having more than five clients a day and/or a partner knowing that sex was sold. Age was also an associated factor. Contrary to expectations, inconsistent condom use and binge drinking were not significantly associated with HIV status.

Our findings add to a growing body of evidence highlighting that many FSWs in South Africa have a substantially higher burden of disease than the pooled prevalence of 36.9% documented across sub-Saharan Africa, or the 11.8% reported in 50 countries in 2012 [60]. The findings suggest that FSWs in Soweto have an HIV prevalence substantially higher than the South African national average, and of women aged 25 years and older [267]. Prevalence among FSWs in Soweto is also higher than previously recorded among women who have engaged in transactional sex in the township (44.8%)

[34]. However, the prevalence in our study was lower than that documented among FSWs in the Johannesburg site of the SAHMS, where prevalence was reported at 73.1% [16]. The Johannesburg study included a large inner-city immigrant population (31.5%) [16]. In comparison, only 16 FSWs in our study reported having immigrated from another country. This may have been an aggravating factor in the higher prevalence rates reported for Johannesburg, given that 70.6% of migrant FSWs were HIV-infected. Despite the few cross-border migrants, our study confirms the need for interventions geared towards migrant SWs. It further provides evidence of the need for structural level changes to laws and policies which perpetuate HIV vulnerability among FSWs [4].

The importance of education was shown as a key driving factor in the vulnerability of FSWs to HIV. South Africa has a chequered socio-political history, which has led to poor educational outcomes for many women [33, 270]. We found that 75% of FSWs reported incomplete education, compared with 58% in the general population [271]. Poor educational outcomes [33, 270] have been found to fuel an informal sex-for-money economy [4, 33], which increases the likelihood of HIV. South Africa has an unemployment rate of 27.1% [272], and people with secondary school qualifications have a distinct advantage over their uneducated counterparts in obtaining employment within the formal economy. In our view, the overall low levels of education found in our study contribute in multiple ways to increased vulnerability to HIV and economic marginalisation.

Our findings highlight the vulnerability of women over 25 years, and the substantial burden of disease among women over 30 years, two-thirds of whom were HIV-infected. Research has shown HIV prevalence peaking in FSWs in Cape Town and Durban for women of a similar age [16]. By comparison, HIV prevalence in Johannesburg was previously found to peak in sex workers aged 16–24 years [16]. One study, which included a small convenience sample of FSWs, found that the risk of HIV decreased with age [61]. Our study, however, suggests that interventions geared toward HIV

prevention among SWs <30 years are vital in addressing FSW vulnerability to HIV acquisition. It further highlights the need for strong HIV treatment programs for women >30 years in Soweto.

Correct and consistent condom use in the past month was not associated with HIV-infection in this study. While consistent condom use is effective in preventing HIV infection [11, 140], it is unlikely that these FSWs became infected within the timeframe referred to in the study (preceding month). This null finding may indicate the equally chaotic nature of both HIV positive and negative FSWs trying to protect themselves and their clients. Our findings suggest that condom use at last sex may be both an inflated and inadequate measure of consistent condom use. Shai et al [221] highlight the importance of multiple measures of condom use to develop an adequate understanding of consistency over time. Using a similar measure, we observed a decline in consistency between condom use at last sex (85%) and our measure of correct and consistent condom use (22.3%). While recent trends have indicated that SWs consistently use condoms with their clients [16, 72], our findings suggest that a new measure of condom consistency is required. Furthermore, the extremely low correct and consistent condom use reported in the Soweto environment is alarming, particularly given the mass promotion of condoms as a safe sex mechanism. In this environment, usage may be influenced by other factors such as exposure to violence [34, 73], which has been reported to be high across the township [178].

Approximately three quarters of respondents had not told their partners that they engaged in sex work. Three quarters of those who had disclosed their profession were HIV-infected, more than half of whom reported condom use with their IP, possibly to protect him. It is likely that an IP's knowledge of a SW's profession stems from the IP being a former client. Thus, knowledge of her vocation may be mediating the relationship between other partner related factors and HIV vulnerability. This requires further research to understand what partner factors relating to knowing that sex is sold, play a role in HIV vulnerability.

Dry sex or douching was associated in bi-variable analysis with HIV, and may indicate the vaginal cleaning practices associated with more common vaginal infections for HIV-positive women[77]. By contrast, FSWs in Kenya were twice as likely to acquire HIV if they douched with water and almost four-times the likelihood of HIV from douching with soap [78]. The use of lubricant and the practice of hiding menstrual blood by inserting an object into the vagina have not been well documented in the literature. Hiding menstrual blood has been anecdotally documented by local SW organisations. The practice involves the insertion of objects such as a kitchen sponge, cotton wool, a cloth, or tampon into the vaginal canal to prevent blood from showing during and after the sale of sexual services. In a sub-analysis, hiding menstrual blood was found to be associated both with reporting recent STI symptoms and client violence (analysis not shown). STI symptoms were associated with increased vulnerability to HIV. This suggests that it is vital that SW-specific practices need to be better documented and understood to ensure that interventions can be developed which are both appropriate to the FSW community and target their vulnerability to HIV.

9.4.1 HIV DRUG RESISTANCE

In addition to the findings on HIV, this study included a component assessing HIV-1 drug resistance amongst FSWs who had viral loads ≥400. Disturbingly we found that one in four FSWs who were treatment naïve had TDR. This highlights the vulnerability of FSWs in Soweto to the sexual acquisition of HIVDR, and the resulting impact upon both treatment options and long-term survival. Additionally, more than a third of FSWs who were not virally suppressed had HIVDR (45/119), and three quarters of those on treatment but failing to suppress had HIVDR (14/19). This suggests the importance of providing services to SWs that they can actively engage in, and it highlights the importance of proactive monitoring of VL within sex work programs to ensure that timeous decisions are made in response to treatment failure. Clinical settings that provide services to SW may also be an environment to expand existing highly centralised VL testing services with technology capable of polyvalent testing (HIV VL, HPV and TB as example) that can be performed at the point

of care. Such technology is becoming available such as the GeneXpert (Cepheid, Sunnyvale, CA) platform [277]. Furthermore, only mutations relating to first line regimens were found amongst treatment naïve SWs, highlighting the possibility that a quarter of FSWs will fail first line therapies for reasons unrelated to adherence. Our data highlights that most FSWs who are on treatment are adherent and virally suppressed. Findings also suggested that the VL of those who had HIVDR mutations was high, thus potentially resulting in the onward transmission of HIVDR in cases where mutations are more robust.

Our findings highlight the potential for sexually transmitted HIVDR. While, previous research has measured transmitted HIVDR at between 9-14% [96, 97], we found that more than one quarter (27,4%) of FSWs who were not virally suppressed and who reported being treatment naïve had HIVDR mutations. Research has previously shown that men who purchase sex are more likely to be HIV positive [151], not use condoms and have been found to be more violent when compared to men who do not purchase sex [27, 138, 149]. These partner behaviours in combination with the findings of this study highlight the increasing vulnerability of FSWs to HIV. Interventions which target partners of SWs are urgently needed to address both sexual risk behaviours and treatment adherence. Research is urgently needed to understand the prevalence of HIVDR amongst partners of FSWs and their transmission dynamics.

We found that the majority of FSWs in our study and who were on treatment (118/269), were virally suppressed (100/143). Extrapolating from this, we suggest that once on treatment, FSWs are likely to be adherent to their ART regimens. However, our data also shows that more than 75% of FSWs on treatment who were not virally suppressed have compromised first line regimens due to HIVDR. These FSWs ideally need to be managed according to the national protocol for virologic failure, which may result in being switched to a second line regimen. Given our previous findings regarding

TDR, it is also possible that some of these failures are due to the sexual acquisition of HIVDR and not non-adherence.

Amongst those who are on treatment or defaulting treatment, it is important to note that several factors limited the ability of FSW to be 100% ART compliant. Research has shown that SWs are exposed to high levels of violence [16, 202], and that violence impacts women's ability to be ART adherent [1]. Additionally, policing officials have been documented withholding access to ART for SWs in custody [14]. In addition, the population is particularly vulnerable to being displaced from the healthcare system. These factors are particularly critical in ensuring effective adherence to ART. We found that almost 75% of the sample who reported being on treatment but were failing to suppress had drug-resistant mutations – the most likely scenario is that these mutations represent acquired resistance, and it suggests that treatment interruptions have likely been experienced by these individuals. Given the complexities of their lives, many of these interruptions will likely be beyond the individual level of control and require renewed efforts to address the various structural factors which serve to drive the epidemic and SWs inability to effectively engage with health systems. Another finding among those on treatment with an unsuppressed viral load is that wildtype virus was identified upon genotypic testing in 26,3% of them (5/19). This illustrates another recognised use of drug resistance testing – the presence of wildtype virus in these individuals suggests non-adherence to treatment as the cause of the virologic failure [93]. This can avoid prematurely switching to a costly and burdensome second line regimen when the virus may still have been susceptible to the original one.

Drug resistance as a percentage of the total number of HIV positive participants in our study was higher than has previously been found amongst a SW cohort in Kenya (16.7% vs. 8.3%) [102]. Our findings were within a similar range to those from two Argentinian FSW studies (18.8-19%)[103, 104]. However, our study sample included individuals who were self-report treatment adherent as

well as treatment naïve and treatment defaulters, whereas previous studies included only individuals on ART (verified and self-report, respectively). While modelling estimates suggest that in certain scenarios outlined previously HIVDR will be prevalent amongst 32% of the HIV positive population by 2032[96], our findings suggest that HIVDR may be increasing to this point as it is already at 16% amongst the Soweto SW population and that further research is urgently required to better understand this.

The finding that HIVDR was prevalent in more than one-third of FSWs who were treatment naïve but had a high viral load is of concern. It suggests the prevalence of sexually transmitted HIVDR amongst sex workers. Further that there was a phylogenetic cluster of two women suggests that HIVDR may be spread through the sexual networks which SWs form part of. Further to this, there needs to be improved clinical oversight for populations with a high exposure to HIV and HIVDR. While the use of a nurse initiated model has dramatically improved South Africa's HIV landscape, it is not necessarily an appropriate model for certain key infected and at-risk populations. As such, it is recommended that models for improved clinical oversight be reviewed and improved for urgent implementation in sex work programs in South Africa, to avert an upsurge in transmitted HIVDR across the sector.

The finding that there was 1 phylogenetic cluster amongst treatment naïve FSWs adds to our concern in that it suggests a common source to their infection, who likely has multiple other partners, is inconsistent in condom use, [27, 138, 151] and may transmit HIVDR to other persons. In our study, less than half of FSWs had initiated ART and were currently on treatment, which was higher than in the SAHMS (45.6% versus 12.2%) [16]. This suggests that there are fundamental differences between FSWs in Soweto [146] from the overall metropolitan of Johannesburg [16]. This could it part be explained by the varying profiles of FSW between the township [146]. Similarly, to the SAHMS, we found that almost all FSWs in our study had previously tested for HIV, with < 20% of

all HIV positive FSWs being unknown positives, and of these, less than one-third had unsuppressed viral loads. This suggests that FSWs in Soweto are testing for HIV and that there is the potential for linkage to care to initiate and monitor their response to treatment. Individuals with unsuppressed viral loads were also more likely to have a lower CD4 count than those who were virally suppressed, suggesting poorer health outcomes for a subset of our sample group.

9.5. OVERALL

In this study, multiple pathways to HIV for FSWs in Soweto are shown. Structural drivers of risk amongst these women, had simple and direct pathways. Violence mediated three pathways to HIV, all beginning in exposure to childhood abuse. The pathway from childhood abuse, through violence, then to mental health factors and leading to sexual risk behaviours resulting in HIV were the strongest. Importantly, these findings are in line with the model developed by Jewkes et al. [281], showing the importance of violence and mental ill health in HIV vulnerability.

The model presented in Chapter 8 [278] shows four indirect paths to HIV that were mediated by variables which measured aspects of mental health, substance use and the well-being of FSWs. These variables were PTSD, internalised stigma, self-esteem and binge drinking. The paths mediated by these mental health factors originated in child abuse, age of entry into sex work and the number of clients (which also formed part of the pathway). There was a common order to the mediating variables from self-esteem through binge drinking, to number of clients and HIV. The variable in the paths prior to this were either internalised stigma or, in the child abuse/violence pathway, PTSD. This is largely consistent with previous models on the role of psychological distress amongst women, where the relationship between violence and HIV was mediated by mental ill health [281]. Interestingly, the self-esteem variable operated in such a way that higher self-esteem was related to greater risk. All of the FSWs scored in the low-moderate range of self-esteem, suggesting considerable underlying psychological distress [265]. Evidence shows that there are overall low

levels of self-esteem amongst FSWs in Soweto. Interestingly, higher levels of self-esteem (although still relatively low) were likely indicative of a coping strategy masking their distress [265]. Through unconscious defence mechanisms, it is likely that they are attempting to avoid or manage overwhelming feelings of anxiety, shame, or other emotional experiences associated with engaging in sex work, while maintaining their self-esteem [282]. Thus, our model suggests that greater levels of internalised stigma contributes to more primitive, manic defence mechanisms measured here through higher self-esteem. This distress results in greater levels of binge drinking. Heavy drinking functions both to hide the pain of engaging in highly discriminated against and stigmatised sexual encounters (selling sex), and facilitates the context for meeting larger numbers of clients, and thereby drives HIV risk. Finally, our study shows the cyclical nature of mental health and behavioural factors, with greater numbers of clients leading to more internalised stigma, which has a pathway back to greater numbers of clients, through self-esteem, and binge drinking, finally resulting in HIV. Thus, building on previous research from the general population which postulated a model of vulnerability inclusive of violence, mental health and HIV[281], our study shows that HIV vulnerability amongst SWs functions through causal pathways connecting violence, mental health related issues and risky sexual behaviours.

Findings suggest a continuum of vulnerability from childhood into adulthood for FSWs in Soweto. In considering the model of vulnerability presented in conjunction with the current rollout of programs for SWs in South Africa, it is clear that the focus of HIV prevention has remained at the tail end of the vulnerability continuum, focusing on biomedical and behaviour modification interventions. Our study shows the importance of building a stronger evidence-base for intervention development. Little is known about how to prevent violence amongst FSWs in South Africa, and there is limited evidence on how to address the complex mental health needs of this populations given their ongoing exposure to violence. Given the scaling up of a National Sex Work HIV Plan, it is important that

such questions are posed and that future research into HIV prevention interventions address violence prevention, stigma and discrimination, and mental ill health as key drivers of the epidemic. Given findings showing the high rates of HIV drug resistance amongst this population and suggestive of adherence concerns[283], it is vital that we begin to understand HIV treatment in line with factors beyond the current biomedical and behavioural interventions. When considering that FSWs often have more immediate concerns than HIV [146], the importance of understanding mechanisms to address the full scope of their vulnerability becomes apparent.

The findings are consistent with those showing the inverse relationship between education and HIV. Evidence suggests the importance of education as a prevention intervention. South Africa's education system is rife with socioeconomic and behavioural disparities, driving a poor standard of education and high student drop-out rate. Furthermore, these findings showed the covariance between education and age of entry into sex work, suggesting that greater levels of education may result in a later entry into sex work which did show some protection towards internalised stigma, as a mediated pathway to HIV, and in a direct pathway of protection for HIV. Our study highlights the critical need for the South African Government to expedite a dramatic improvement to education as a key prevention intervention. This would also see economic stimulation, resulting in improved employment opportunities, enabling young women to choose their profession rather than have it thrust upon them as a survival mechanism.

Findings also show an extremely high prevalence of violence, and this is often driven by discrimination against the SWs. Both experiences of discrimination and internalised stigma were fundamental components of HIV vulnerability, and this model further confirms previous findings that violence against sex workers is a hate crime[202]. Given that SWs are exposed to aggressive forms of masculinity, and that violence against them is rooted in discrimination against the profession, legislative frameworks which criminalise the profession urgently require revision. Furthermore, and

as decriminalisation is likely to be a long-term solution, mechanisms to make SW safer for the persons engaging, need to be understood and interventions developed which can be implemented in the interim.

9.6. METHODOLOGICAL LEARNINGS

This study had several methodological learnings which can benefit future researchers, particularly those working with marginalised populations. Firstly, the importance of involving the population under study in all aspects of the study proved vital to the success of this project. Sex workers were trained as counsellors and interviewers, as data capturers and coupon managers. They were engaged in the questionnaire design and development, in the database setup and its ongoing management. This active engagement ensured that we had a team of well informed and capacitated SWs who could proactively engage in managing the study and ensuring high quality data collection. Potential participants were screened by women who were themselves SWs, and so could probe about sex work specific behaviours and practices for Soweto, thus enabling them to identify non-SWs for exclusion from the study. The team very proactively engaged in data collection, reflecting during the weekly study updates on their challenges and successes. They gave each other guidance and advice on how to ensure that the best data was collected which reflected what SWs were telling us. This was especially important in relation to questions on physical and sexual violence, which often required additional probing to understand, for example, the number of times a woman had been raped. It was also important to ensure that staff could undertake trauma containment for participants who frequently reported that this was the first time they had spoken about a given event of trauma, or about their mental health concerns. Such a strongly participatory engaged research study ensured that interviewers were able to rapidly build a rapport with participants. The study team felt that this translated into more honest responses to difficult questions around sexual behaviours, including condom usage, and practices such as hiding blood. However, not all topics were open for discussion.

We did note that female labial stretching was a topic which was deeply steeped in tradition and which multiple women refused to discuss with the interviewers, who had not themselves experienced "maLebe" (labial stretching).

Secondly, the use of a respondent driven sampling as a recruitment strategy was highly successful, and is recommended for use in other key and hard to reach populations. While the first two weeks of the study were relatively quiet in terms of the number of enrolments per day, as the number of coupons being handed out steadily increased, the site became overrun with potential recruits arriving to be screened in week 3-5. By 07h00 there was often a queue outside of the clinic door of women waiting, and potential participants continued to arrive at the clinic throughout the morning. The staff had been trained for this potential and managed the situation well, accepting in the first 20 people for screening each morning and requesting the remainder to return another day. Thus, our study experience shows that where a sex work population is well networked, RDS can provide a very simple mechanism for successful recruitment, which is not onerous for the study staff.

Thirdly, REDCap data management tool became a point of empowerment for the interviewers and coupon manager, who were able to actively engage in live data capturing during interviews. The database was developed with built in skip patterns, algorithms, validation checks and logic which guided the interviewers through each interview and ensured that there was almost no missing data for the questionnaires and HIV rapid tests. Additionally, the system enabled this PhD candidate to monitor data collection within moments of a form being completed, and to request clarification or comment from the interviewers – which could be resolved prior to the participant leaving the site, if need be. The staff were also empowered to develop other databases for new projects, thus building their capacity and ability to engage in the formal working environment.

Fourthly, the use of respondent driven sampling weights within multivariate logistic and multinomial regression models is not well understood in the literature. The mathematics underpinning RDS

multivariate analyses is in its infancy thus limiting what analyses can be conducted with RDS weights. While various sensitivity analyses conducted yielded no clustering effects, and minimal to no variance is seen between adjusted and unadjusted analyses, there is a need for improved understanding of the math underlying RDS multivariate analyses, which are beyond the scope of this thesis. Careful consideration was taken to ensure that network sizes are realistic, and fit within an appropriate range of values, thus ensuring that the weights calculated were appropriate for use at this level of analysis. Our findings suggest that with careful use of the weights, and that after extensive sensitivity analyses, RDS weighted data can be used to present alternate models of risk and likelihood. However, the use of weights in more complex modelling such as those presented in Chapter 8 were not tested and future research could explore the implications of incorporating RDS weights within complex modelling analyses.

9.7. STUDY LIMITATIONS

Our study had several limitations. The study includes only FSWs and no other women living within the Sowetan township as a comparison. Importantly, female partners of male clients are also at risk, but are not identifiable to us in the present study. The data were collected cross-sectionally, which limits out understanding of temporality. Some variation was observed between adjusted and unadjusted bivariate analysis in the RDS analysis; understanding of the use of RDS weights in multivariate analysis is limited [273, 274]. However, the difference between adjusted and unadjusted analyses suggests that when used in conjunction with sensitivity tests, RDS data provide an alternative model for use in weighted multivariate logistic analyses.

Violence perpetrated by police and gang rape were possibly underreported and may be due to their order in the survey document (asked after client and intimate partner experiences) that could have resulted in participants feeling emotionally overwhelmed and unable to disclose further violence exposure. Other forms of violence were not asked about in this study, including police neglect, and

violence by family members and strangers. These issues were raised by participants during interviews, who often went on to describe incidents of sexual assault by other perpetrators, which were not included within our study questions. As such we feel that our findings underreport violence prevalence. The study focused exclusively on FSWs, with no clients included. There was some variation between adjusted and unadjusted analysis. Weights were not included in the covariance matrix.

The CES-D measure did not provide a diagnostic measure of depression, but rather an indication of high levels of depressive symptoms. The AUDIT-C short measure is possibly inadequate to assess chronic binge drinking, and despite efforts to improve the measure, results should be interpreted with caution. Future work needs to understand the defence mechanisms underpinning the overall low self-esteem in this sample, and how this is functioning in combination with other mental health concerns. There was some variation between adjusted and unadjusted analysis, however these were minimal. The study did not screen for other psychopathology and so cannot comment on other mental health concerns among FSWs in Soweto.

Our study had several limitations including insufficient information on the temporal sequencing of HIV seroconversion and associated factors such as migrancy, entry into sex work, condom use and alcohol consumption. Implicit in the analysis is the assumption that HIV seroconversion followed these associated factors, but we are unable to confirm that this is the case. Our analysis assumed that recent sexual behaviour is indicative of past sexual behaviours, but caution should be taken in interpreting these results.

Overall, the sample size for this study was small, and was limited by budgetary and temporal constraints, however it was supported by out sample size calculation. There was reason to believe that's some lower prevalence associated factors could have been influenced by limitations in the power to detect significant associations. The sample size to analyse HIVDR data was small and as it

was a subset analysis, RDS weights could not appropriately be used, as the subset sample no longer represented a networked group of FSWs, but rather a purposefully selected group of women who sold sex and were HIV infected with a VL ≥400. Thus, this component of the broader study should be interpreted with caution in terms of generalisability of findings. Treatment status was self-report and may not be an exact reflection of lifetime exposure to ART, especially for women who had received PMTCT (although this was probed during the survey). For sample analyses, unsuppressed viral loads were defined as VL ≥500 copies/ml and not VL ≥400 copies/ml as in previous studies, thus 2 samples were excluded from HIVDR testing.

As this study draws from a small sample of FSWs in Soweto, generalizability should be interpreted with caution. Despite drawing from an RDS dataset, weighted data was not included within this study due to the limitations of presently available RDS software. Importantly, we were unable to explore gender equality. The data is cross sectional, limiting our understanding of temporality, particularly the timing of the HIV infection. However, measures were used which in themselves refer to different time periods across the lifetime and as such are able to address some issues of temporal sequencing.

9.8. IMPLICATIONS FOR INTERVENTION DEVELOPMENT

Currently, interventions geared to SW in South Africa are guided by the South African National SW HIV Plan 2016-2020. The development of this plan is a laudable achievement towards ensuring the rights of SWs, and that access to basic HIV health related and legal services are incorporated into programs being implemented. However, the findings from this thesis highlight the exclusive nature in which HIV prevention and treatment programs for this population are privileging biomedical and behavioural change interventions to the detriment of a systemic approach which would see the inclusion of strong mental health and violence prevention interventions. This would show an understanding that without an inclusive and multi-sectoral approach, HIV vulnerability for FSWs

will continue unabated. Current interventions, while positive in their discourses around multi-sectoral responses, have failed to provide a balance of interventions. This is due to funding streams currently being leveraged to assist SWs through HIV-related biomedical and behavioural interventions which exclude effective mental health and violence prevention interventions. Funders need to carefully consider the evidence from this and other studies which show how critical it is to utilise approaches that target the varying contextual factors impacting upon SW vulnerability to these three comorbid epidemics. Furthermore, interventions which address violence and mental health in their own right, are also urgently required for individuals who are not able to access these via HIV platforms. Table 9-2 summarises the main findings and intervention suggests resulting from this thesis.

Table 9-2: Summary of implications of main findings for intervention

THESIS CHAPTER	FINDINGS OF THESIS	IMPLICATIONS FOR INTERVENTIONS
Chapter 4	- We describe exposure to violence by intimate partners, clients and police for both the past year and ever, amongst FSWs in Soweto. Our findings show that past year levels of violence are extremely high with more than half being exposed to IPV, and almost half experiencing physical or sexual violence by a client. - Lifetime exposure to violence for FSWs in Soweto is extremely high, with only 14.4% reporting no violence exposure. Intimate partner violence was the most likely form of violence to co-occur. - Exposure to violence during childhood, when dichotomised as none/a few versus frequently/very often, was consistent with findings for the general population. However, exposure to sexual abuse was substantially high (44.3% versus 35.4%) - Lifetime prevalence of sexual assault was 62.4%.	- Findings from this study highlight the desperate need for a National Gender Based Violence Strategy, which would ensure not only effective prevention interventions be rolled out, but that there is comprehensive and inclusive access to post trauma care. - Interventions need to focus on both paying and non-paying partners of SWs, as key drivers of violence perpetration. Interventions which address gender inequality and the aggressive forms of masculinity perpetrating violence against SWs need to be urgently undertaken as companion programs to the current SW projects being implemented across South Africa. - Legislative frameworks criminalising SW need to be reformed as a key aspect to addressing discrimination against persons engaging in the sale of sexual services.

THESIS CHAPTER	FINDINGS OF THESIS	IMPLICATIONS FOR INTERVENTIONS
Chapter 5	- Findings show a high prevalence of mental health concerns, with 38.4% suffering from either depression or PTSD, and 32.7% from both depression and PTSD. Overall, 68.7% of FSWs in Soweto have symptoms of major depression. - The co-occurrence of violence was shown to increase the risk of mental health complications by as much as 4 times as compared with no violence exposure.	- The implementation of effective violence prevention interventions is a key aspect of preventing the mental health conditions seen in this study. As such, sex work projects must include effective GBV strategies targeting perpetrators of violence as a core aspect of preventing MH conditions. - Research is needed to understand the mechanisms to treat mental health complications for SWs. This should be cognisant of budgetary constraints as well as the scale of the mental health epidemic in this population. It is likely that programs such as Mindfulness Based Stress Reduction, would be effective in this population and this hypothesis should be tested. International evidence has shown the impact of stress and stress reduction techniques (such as mindfulness practices) upon HIV disease progression[278]. - South Africa needs to scale up access to substance abuse treatment programs, in particular ones which cater to SWs.

THESIS CHAPTER	FINDINGS OF THESIS	IMPLICATIONS FOR INTERVENTIONS
Chapter 6	- More than half of FSWs in Soweto were HIV infected. The HIV prevalence of FSWs in Soweto was lower than previously described for FSWs in Johannesburg, South Africa (53.6% versus 71.3%). - A variable was generated to understand consistency of condom use which was more complex in its development, and potentially allowed for an improved estimator of consistent condom use over the previous month. - Education and being born outside of the Gauteng Province, wherein Soweto is located, were both found to be strongly associated with an increased likelihood of being HIV positive. An intimate partner knowing that she sold sex was also significantly associated with being HIV positive.	- Sex workers and their partners (paying and non-paying) require improved access to HIV prevention and treatment modalities to reduce their vulnerability to the disease. - Interventions to address adherence to medication need to be explored. These must be cognisant of the mental health needs and violence exposure of the population. - Care should be taken in the development of measures to assess consistent condom usage. - Quality education and economic stimulation in South Africa are urgently needed to allow women to have an active choice in their economic future. Furthermore, programs offering up-skilling and supplementary incomes would reduce the risk of HIV for women engaging in sex work. - We found that a partner knowing that sex was sold was important to HIV, yet we were unable to effectively understand this. Research is required to understand this dynamic and how it can be leveraged as a protective factor for FSWs.
Chapter 7	- Overall, 16% of HIV positive FSWs had HIVDR. Of those who had viral loads greater than 400, and who were treatment naïve, almost 40% had transmitted HIVDR, suggesting the possible sexual acquisition thereof. Three quarters of FSWs who reported adhering to their treatment but were in virologic failure appeared to have acquired HIVDR.	- Our findings show the critical need for ongoing surveillance of HIVDR amongst SWs. This could be implemented through current SW programs which are already providing HIV testing and related services. - It is important to extend this work to include the broader sexual networks within the sex work sector, so as to understand psycho-social and behavioural drivers of HIVDR, and develop interventions targeting these.

THESIS CHAPTER	FINDINGS OF THESIS	IMPLICATIONS FOR INTERVENTIONS
Chapter 8	- There were multiple pathways to HIV for FSWs in Soweto. Pathways to HIV vulnerability were complex and were mediated by both violence and mental health needs, which led to increased sexual risk behaviours resulting in HIV. - Building on previous research on structural drivers, sexually risky behaviour, violence, mental health and HIV, our study provides strong evidence of the causal pathways among FSW linking their vulnerability to HIV. - The model had four indirect paths to HIV that were mediated by variables which measured aspects of mental health, substance use and the well-being of FSWs - Findings suggest a continuum of vulnerability from childhood into adulthood for FSWs in Soweto - The model suggested that greater levels of internalised stigma contributes to more primitive, manic defence mechanisms measured here through higher self-esteem	- Understand and implement multidisciplinary and collaborative interventions to address the continuum of vulnerability for FSWs. These must extend beyond the current and traditional notions privileging biomedical and behavioural interventions, which function at the tail end of vulnerability. They should also link closely with economic and educational projects to ensure that women are empowered to engage in the formal economy, should they so choose. - Understanding and implementing interventions to address discrimination and violence against SWs, as they impact the FSWs' ability to cope and result in manic defence mechanisms which further their vulnerability. Sustainable and easily disseminated methods to improve coping skills need to be explored - The current National Sex Worker Program would do well to ensure that programs being implemented in South Africa are geared to addressing the vulnerability continuum. - Innovative and novel interventions need to be explored which more realistically consider vulnerability on a continuum, and which target multiple levels of susceptibility in order to prevent new HIV infections

ADDITIONAL FUTURE RESEARCH

The findings from this study has resulted in improving our understanding of multiple factors associated with HIV infection amongst FSWs in Soweto. However, it has also enabled additional research questions to evolve, which will guide future research. Critical question which have been identified from this research include:

- Understanding perpetrator specific patterns of violence and associated factors to ensure that SW program implementers can address areas of concern.
- Understanding the impact of violence and mental health on adherence to HIV related medications.
- Understanding mechanisms inhibiting the uptake of consistent condom use.
- Mapping the prevalence of HIVDR amongst other SW populations, their clients and intimate partners.
- Understanding prior exposures to ART, whether through PMTCT programs or drugs such as Nyoape as they impact upon HIVDR amongst FSWs
- Mapping sexual networks and phylogenetic clustering in the sex work sector.
- Understanding HIV prevalence and associated factors amongst male and transgender-female sex workers
- Understand the mental health needs of the peer educators who have all been, or currently are, sex workers, and are required to provide services within sex work programmes in South Africa, and thus may be affected by as high a prevalence of mental health conditions, requiring urgent treatment and support.

9.9. CONCLUSION

The intersection between gender inequality, poverty, violence and mental health [3] creates a public health crisis centring on HIV. Sex workers have a heightened vulnerability to violence with the prevalence of polyvictimization confirming that they are positioned on the apex of South Africa's broader violence epidemic. The power differential between FSWs and the men with whom they interact, intensifies their vulnerability. The current legislative framework functions to legitimise violence against SWs through endorsing discrimination and thereby encouraging ideas that there could be "justifiable" or "deserved" violence against SWs. The South African Government needs to take heed of the growing body of knowledge highlighting the vulnerability of this population and begin safeguarding their human rights as part of addressing the overall violence epidemic in South Africa. It is imperative that legislation criminalising SW be reviewed as a fundamental mechanism to

addressing violence against SWs. Exposure to such high levels of violence are likely to hamper HIV prevention and treatment interventions targeting FSWs. Thus, there is an urgent need for a programme of research to define what works to prevent violence against SWs from paying and non-paying partners, and clearly define and implement appropriate and inclusive sex work sector violence prevention interventions. Taken together, our findings suggest the normalisation of violence against SWs which requires collective attention by policy makers, programme implementers, researchers and community members.

Globally and in South Africa, mental health is a largely neglected public health concern. Our findings highlight the burden of vulnerability for FSWs in Soweto, who are exposed to deleterious living and working conditions while being afflicted with a serious burden of mental health conditions. Given the limited availability of mental health services, including rehabilitation centres, findings further underpin the importance of addressing mental health challenges as a critical component of comprehensive wellness for SWs. Despite evidence of SWs vulnerability [16, 160, 192, 193, 202], there is little research on the mental health needs of this population. This is a critical gap in the literature and is of concern not only due to the detrimental impact mental health has on individuals' lives, but also because South Africa is in the process of scaling up sex work programs – meaning that an opportunity is present to intervene. It will require innovative and flexible use of available funding mechanisms to urgently redress this situation. They also highlight the dearth in research to understand the role of mental health concerns amongst SWs in South Africa, as well as the impact which mental health may be having on the uptake of HIV prevention and treatment technologies amongst this key population. Mental health should be considered as an important component in both policy review and programmatic implementation to ensure that the human rights of this population are met and that they can achieve overall health beyond the HIV agenda.

HIV prevalence among FSWs in South Africa is excessively high and requires urgent action to arrest the unabated growth of the disease. Our findings highlight the vulnerability of FSWs to the disease, which is strongly driven by a combination of structural, biological and behavioural determinants. Soweto represents a microcosm of South Africa in terms of the epidemic of violence and HIV plaguing society, and which is often beyond the control of individuals. The South African government needs to urgently address structural factors impacting entry into and practices used in sex work. These factors often function in highly complex ways, and require innovative and alternative thinking beyond the scope of traditional HIV prevention and treatment. This would ensure that SWs are empowered to protect themselves effectively against HIV. This study also highlights the need for improved access to ART services as both a treatment and prevention strategy. At the same time, our findings suggest that there may be more immediate concerns facing FSWs which require more urgent attention. In line with Shannon et al [4, 275], these individual and structural level factors function to drive the epidemic and require inclusion within SW HIV programs. In the case of SWs, capacity development in the form of adult education, coping skills and mindfulness practices may prove valuable tools in the HIV armoury. Furthermore, in comparison to the SAHMS findings [16], these findings highlight the critical value of profiling a given population to ensure that interventions are contextually tailored. Such action will ensure that access to treatment and prevention through rights-based services is effectively implemented in South Africa in line with the *South African National Sex Worker HIV Plan 2016–2020 [59]*.

Our study suggests there may be alarming rates of HIVDR being transmitted between clients or intimate partners and FSWs in Soweto. This will potentially result in a large proportion of treatment naïve FSW having compromised first line therapies. Given the high HIV prevalence in this population and their vulnerability to violence and other health concerns[16, 146], it is critical that we begin to understand transmission dynamics and the outcomes of TDR. In addition, we found that three quarters of FSWs failing treatment had likely developed ADR. This suggests the frequency of

treatment interruptions in this population which needs to be better understood for intervention development. Further, routine surveillance of VL must be rigorously undertaken amongst such high-risk populations to ensure that failure to suppress is proactively managed and second line therapies implemented timeously. Given the scale up of the South African National Sex Worker HIV Plan 2016-2020 [59], it is important that programmers are aware of the potential for first line resistance, and that more than one quarter of FSW initiated onto treatment and who are in virologic failure, may already have some form of resistance to first line. Furthermore, sex work programs in South Africa currently leverage nurse initiated ART for clinical service provision. Our data highlights the need for greater clinical oversight and understanding within these projects to ensure that resistance concerns are appropriately monitored and managed. Furthermore, routine HIVDR surveillance amongst key populations should become a priority within South Africa. This will ensure that healthcare officials, policy makers and program implementers are able to monitor and rapidly respond as HIVDR continues to show increasing trends amongst this population.

Building on previous research on structural drivers, sexually risky behaviour, violence, mental health and HIV, our study provides strong evidence of the causal pathways among FSW linking their vulnerability to HIV. We have shown the importance of a multi-layered understanding of FSWs' vulnerability to HIV, and the complexity of intersecting pathways. The South African National Sex Work HIV Plan is underpinned by a biomedical and behavioural foci on HIV prevention with limited scope to drive mental health and violence as key components of SW vulnerability to HIV. This means that in terms of a vulnerability continuum, the focus of interventions is being placed at the tail end of vulnerability rather than earlier in the continuum, which would likely yield more sustainable results. This highlights the urgent need to diversify service offerings to meet the needs of the population rather than focus largely on sexual risk behaviours and treatment options for HIV prevention. Without more complex understandings of HIV vulnerability, it is impossible to fully appreciate the policy and practice interventions required. Thus South Africa will continue its

burgeoning HIV epidemic and our prevention and treatment interventions are likely to have limited effect. Through developing a more nuanced and complex understanding of vulnerability in key affected populations, we can clearly see the role of mental health and violence as they impact upon the HIV epidemic. It is critical that the South African Government understand that violence and resulting, unaddressed trauma-related needs are likely hampering our HIV prevention and treatment efforts [1, 2]. In addressing violence, it should also be noted that research to understand mechanisms to engage paying and non-paying partners of SWs needs to urgently be undertaken. The lack of male inclusion in sex work programs is an oversight and inhibits the ability to engage in gender transformative interventions to improve gender equality, a key driver of violence perpetration [3]. Thus, these findings highlight plausible reasons why the current HIV focus is and will continue to fail SWs. These findings support a change in the immediate HIV policy and funder environment with a view beyond the immediate HIV focus and to include strong mental health and violence prevention and treatment interventions as equally important components in the HIV armoury.

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11. APPENDICES

APPENDIX	DESCRIPTION	PUBLICATION STATUS	EVIDENCE
A	Ethics Clearance Certificate	N/A	Certificate
B	Turnitin report (11%)	N/A	Page 1 of the report
C	Prevalence and patterns of victimization and poly-victimization amongst female sex workers in Soweto, a South African township: A cross sectional, respondent driven sampling study.	Accepted for Publication, Global Health Action	Acceptance letter
D	Depression and post-traumatic stress amongst female sex workers in Soweto: prevalence and risk factors. A respondent driven sampling study.	Under review, PlosOne	Proof of submission
E	Cross-sectional study of female sex workers in Soweto, South Africa: factors associated with HIV infection. Plos One.	Published, PlosOne	Page 1 of publication
F	HIV-1 viral infectivity and drug resistance amongst female sex workers in Soweto, South Africa: A cross sectional study.	Provisionally Accepted, PlosOne	Proof of resubmission with responses to reviewer comments

11.1 APPENDICE A: ETHICS CLEARANCE CERTIFICATE

R14/49 Ms Jenny Coetzee

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M150736

NAME: (Principal Investigator) Ms Jenny Coetzee

DEPARTMENT: Public Health
Perinatal HIV Research Unit

PROJECT TITLE: Understanding Factors Associated with Infection Amongst Soweto-based Sex Workers

DATE CONSIDERED: 31/07/2015

DECISION: Approved uncoditionally

CONDITIONS:

SUPERVISOR: Prof Glenda E Gray

APPROVED BY: Professor P Cleaton-Jones, Chairperson, HREC (Medical)

DATE OF APPROVAL: 09/09/2015

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Secretary in Room 10004, 10th floor, Senate House, University.
I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report**.

Principal Investigator Signature Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

11.2. APPENDICE B: TURNITIN REPORT

Page 1 of Turn It In report

FINALTHESISV2.pdf

ORIGINALITY REPORT

11%	2%	10%	1%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Jenny Coetzee, Rachel Jewkes, Glenda E. Gray. "Cross-sectional study of female sex workers in Soweto, South Africa: Factors associated with HIV infection", PLOS ONE, 2017 Publication	8%
2	www.csvr.org.za Internet Source	<1%
3	Public Health Aspects of HIV/AIDS in Low and Middle Income Countries, 2009. Publication	<1%
4	Marlise Richter. "Sex work, reform initiatives and HIV/AIDS in inner-city Johannesburg", African Journal of AIDS Research, 11/01/2008 Publication	<1%
5	www.pubfacts.com Internet Source	<1%
6	scholar.sun.ac.za Internet Source	<1%

11.3. APPENDICE C: PREVALENCE AND PATTERNS OF VICTIMISATION AND POLY-VICTIMISATION AMONGST FEMALE SEX WORKERS IN SOWETO, A SOUTH AFRICAN TOWNSHIP: A CROSS SECTIONAL, RESPONDENT DRIVEN SAMPLING STUDY

Confirmation of submission from Global Health

GLOBAL HEALTH ACTION, 2017
VOL. 10, 1403815
https://doi.org/10.1080/16549716.2017.1403815

Taylor & Francis
Taylor & Francis Group

ORIGINAL ARTICLE

OPEN ACCESS Check for updates

Prevalence and patterns of victimization and polyvictimization among female sex workers in Soweto, a South African township: a cross-sectional, respondent-driven sampling study

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ABSTRACT

Background: Female sex workers (FSWs) are disproportionately affected by violence from multiple partner categories. This increases their vulnerability to HIV.

Objectives: To describe patterns of violence and polyvictimization among female SWs in Soweto.

Methods: A respondent-driven sampling (RDS) recruitment methodology was used to enrol 508 Soweto-based FSWs using a survey instrument. Raw and RDS adjusted data were descriptively analysed, Spearman's correlation and chi^2 test of association were used to show associations. Polyvictimization patterns are shown within a modified Venn diagram.

Results: The median age of FSWs in Soweto was 31 years, and most had an incomplete education (74.2%). The prevalence of exposure to physical/sexual intimate partner violence (IPV) in the past year was 53.8%, 46.8% by clients, and 18.5% by police. Past year prevalence of sexual/physical violence by any perpetrator category was 70.8% and lifetime exposure was 76.0%. Childhood sexual violence was reported by 44.3%. Lifetime non-partner rape was 55.5% and all rape exposure was 62.4%. As a result of engaging in sex work in the past year, 65.2% women had been discriminated against. Client, police, IPV, and childhood trauma were all significantly associated with one another, with IPV being the most common co-occurrence. Polyvictimization was seen in almost two-thirds of FSWs, and increased with exposure to discrimination.

Conclusion: In Soweto, FSWs are exposed to high rates of violence in multiple forms across their lifetime. Our findings show that violence continues unabated into adulthood at levels far higher than in the general population and overall at higher levels than previously recorded among SWs in South Africa. We argue that violence against FSWs is rooted in discrimination. The disparate burden of violence on FSWs requires urgent interventions to proactively address and reframe the normalisation of violence against all women.

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KEYWORDS
Sex work; South Africa; violence; client violence; intimate partner violence; hate crime

Background

Sex workers (SWs) epitomise South Africa's dual human immunodeficiency virus (HIV) and violence epidemics [1–3]. Despite a constitution lauded internationally for being grounded in human-rights and equal rights for women [4], the country is highly patriarchal with pervasive violence against women [5]. Evidence confirms the high exposure female sex workers (FSWs) have to violence. A study of FSWs in Soweto, South Africa, showed that 53.8 and 55.6% had experienced intimate partner and non-intimate partner sexual violence in their lifetime (respectively). In Johannesburg, 20% of FSWs reported experiencing sexual violence, while 54% reported any physical violence in the past year [1,6]. Globally, violence is associated with inconsistent condom usage, sexually transmitted infection (STI) and HIV acquisition, undermining economic capital, and it has a widespread social impact [7–11]. The resulting mental health complications, including post-traumatic stress disorder (PTSD) and depression, often undermine individuals' effective functioning [11,12]. This may result in substance abuse or a lack of adherence to chronic medications such as antiretroviral therapy (ART) [13]. For these reasons, it is important to understand exposure to violence and the multiple forms of violence FSWs may be exposed to across their lifetime to ensure that programmes can be effectively equipped. Little is known about the patterns and prevalence of victimization and polyvictimization among FSWs in South Africa . Given the launch of the *South African National Sex Worker HIV Plan 2016–2020*[14] and the scale up of sex work programs across the country, understanding the trauma experienced by this neglected and marginalised population is important to developing effective interventions.

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11.4. APPENDICE D: DEPRESSION AND POST-TRAUMATIC STRESS AMONGST FEMALE SEX WORKERS IN SOWETO: PREVALENCE AND RISK FACTORS. A RESPONDENT DRIVEN SAMPLING STUDY

Confirmation of submission from Plos One

PLOS ONE

Depression and Post Traumatic Stress amongst female sex workers in Soweto, South Africa: a cross sectional, respondent driven sample

--Manuscript Draft--

Manuscript Number:	PONE-D-17-37329
Article Type:	Research Article
Full Title:	Depression and Post Traumatic Stress amongst female sex workers in Soweto, South Africa: a cross sectional, respondent driven sample
Short Title:	Depression and Post Traumatic Stress amongst female sex workers in Soweto, South Africa
Corresponding Author:	Jenny Coetzee, MA University of the Witwatersrand Soweto, SOUTH AFRICA
Keywords:	sex work; depression; post traumatic stress disorder; self-esteem; violence; stigma
Abstract:	Background Sex workers in South Africa are exposed to high levels of violence, yet little is known about their mental health needs. This study aims to understanding the prevalence of depression and post-traumatic stress disorder (PTSD) and their risk factors amongst female sex worker (FSWs) in Soweto, South Africa. Methods A cross-sectional, respondent-driven sampling (RDS) survey enrolled 508 FSWs. Raw and RDS adjusted data were analyzed using a chi-squared test of association and multinomial regression for risk factors associated with depression and PTSD. Findings Symptoms of severe depression were prevalent amongst 68.7%, PTSD was 39.6%, and 32.7% suffered from comorbid PTSD and depression. Experiencing ≥3 kinds of violence increased the likelihood of comorbidity (RRR4.1, 95% CI 1.5-11.1,p=0.005). Internalised stigma increased the likelihood of one mental health condition (RRR1.3, 95% CI 1.1-1.4,p=0.001), higher self-esteem was associated with independent (RRR1.1, 95% CI 1.1-1.3,p=0.002) and comorbid conditions (RRR1.2, 95% CI 1.1-1.3,p=0.001). Conclusion Our findings highlight the sizable burden of treatable mental health conditions among FSWs in Soweto. This was driven by multiple exposures to violence, sex work related discrimination and overall moderate levels of self-esteem masking defence mechanisms. This suggests the urgent need to design and integrate services geared to the mental health needs for this population.
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Opposed Reviewers:	
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Question	**Response**
Financial Disclosure Please describe all sources of funding that have supported your work. **This**	The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript

11.5. APPENDICE E: CROSS-SECTIONAL STUDY OF FEMALE SEX WORKERS IN SOWETO, SOUTH AFRICA: FACTORS ASSOCIATED WITH HIV INFECTION. PLOS ONE.

Front page of publication from PlosOne

PLOS ONE

RESEARCH ARTICLE

Cross-sectional study of female sex workers in Soweto, South Africa: Factors associated with HIV infection

Jenny Coetzee[1,2☯]*, **Rachel Jewkes**[2,3☯‡], **Glenda E. Gray**[1,4☯‡]

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Abstract

Introduction

In South Africa, the rate of HIV in the sex worker (SW) population is exceedingly high, but critical gaps exist in our understanding of SWs and the factors that make them vulnerable to HIV. This study aimed to estimate HIV prevalence among female sex workers (FSWs) in Soweto, South Africa, and to describe their sexual behavior and other factors associated with HIV infection.

Methods

A cross-sectional, respondent-driven sampling (RDS) recruitment methodology was used to enroll 508 FSWs based in Soweto. Data were collected using a survey instrument, followed by two HIV rapid tests. Raw and RDS adjusted data were analyzed using a chi-squared test of association and multivariate logistic regression to show factors associated with HIV infection.

Findings

HIV prevalence among FSWs was 53.6% (95% CI 47.5–59.9). FSWs were almost exclusively based in taverns (85.6%) and hostels (52.0%). Less than a quarter (24.4%) were under 25 years of age. Non-partner violence was reported by 55.5%, 59.6% of whom were HIV-infected. Advancing age, incomplete secondary schooling, migrancy and multiple clients increased the likelihood of HIV acquisition: >30 years of age was associated with a 4.9 times (95% CI 2.6–9.3) increased likelihood of HIV; incomplete secondary schooling almost tripled the likelihood (AOR 2.8, 95% CI 1.6–5.0); being born outside of the Gauteng province increased the likelihood of HIV 2.3 times (95% CI 1.3–4.0); and having more than five clients per day almost doubled the likelihood (AOR 1.9, 95% CI 1.1–3.2).

11.6. APPENDICE F: HIV-1 VIRAL INFECTIVITY AND DRUG RESISTANCE AMONGST FEMALE SEX WORKERS IN SOWETO, SOUTH AFRICA: A CROSS SECTIONAL STUDY

Front page of publication from PlosOne

PLOS ONE

HIV-1 viraemia and drug resistance amongst female sex workers in Soweto, South Africa: A cross sectional study

Jenny Coetzee , Gillian Hunt , Maya Jaffer , Kennedy Otwombe, Lesley Scott, Asiashu Bongwe, Johanna Ledwaba, Sephonono Molema, Rachel Jewkes, Glenda E. Gray

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Abstract

Background

HIV drug resistance (HIVDR) poses a threat to future antiretroviral therapy success. Monitoring HIVDR patterns is of particular importance in populations such as sex workers (SWs), where documented HIV prevalence is between 34–89%, and in countries with limited therapeutic options. Currently in South Africa, there is a dearth in evidence and no ongoing surveillance of HIVDR amongst sex work populations. This study aims to describe the prevalence of HIVDR amongst a sample of female sex workers (FSWs) from Soweto, South Africa.

Methodology

A cross-sectional, respondent driven sampling (RDS) recruitment methodology was used to enrol FSWs based in Soweto. Participants were tested for HIV and undertook a survey that included HIV knowledge and treatment status. Whole blood specimens were collected from HIV positive FSWs to measure for CD4 counts, viral load (VL) and perform HIVDR genotyping. Frequencies were determined for categorical variables and medians and interquartile ranges (IQR) for the continuous.

Results

Of the 508 enrolled participants, 55% (n = 280) were HIV positive and of median age 32 (IQR: 20–51) years. Among the HIV positive, 51.8% (132/269) were defined as virologically suppressed (VL < 400 copies/ml). Of the 119 individuals with unsuppressed viral loads who were successfully genotyped for resistance testing 37.8% (45/119) had detectable drug resistance. In this group, HIVDR mutations were found amongst 73.7% (14/19) of individuals on treatment, 27.4% (26/95) of individuals who were treatment naïve, and 100% (5/5) of defaulters. One phylogenetic cluster was found amongst treatment naïve FSWs. The K103N mutation was detected most commonly in 68.9% (31/45) individuals with HIVDR mutations, with 20/26 (76.9%) of treatment naïve FSW with detectable resistance having this mutation. The M184V mutation was found in both FSWs on treatment (12/14, 85.7%) and those defaulting (1/5, 20.0%).

Discussion

More than one third (45/119) of the genotyped sample had HIVDR, with resistance to the NNRTI class being the most common. Almost half of HIV positive FSWs had unsuppressed viral loads, increasing the likelihood for onward transmission of HIV. Disturbingly, more than 1:4 treatment naïve women with unsuppressed viral loads had HIVDR suggesting that possible sexual transmission of drug resistance is occurring in this high-risk population. Given the high burden of HIVDR in a population with a high background prevalence of HIV, it is imperative that routine monitoring of HIVDR be implemented. Understanding transmission dynamics of HIVDR in FSW and its impact on treatment success should be urgently elucidated.

Citation: Coetzee J, Hunt G, Jaffer M, Otwombe K, Scott L, Bongwe A, et al. (2017) HIV-1 viraemia and drug resistance amongst female sex workers in Soweto, South Africa: A cross sectional study. PLoS ONE 12(12): e0188606. https://doi.org/10.1371/journal.pone.0188606

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