

The local dynamics of socio-structural features and HIV stigma in the HPTN 071 (PopART) trial: an analysis of community level data from Zambia and South Africa

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Declaration of Interest statement

We declare that we do not have any financial and personal relationships with other people or organizations that could inappropriately influence our work.

Positionality Statement

Reflecting on our positionality as authors, 11 of the 18 authors are researchers from sub-Saharan Africa, and the remaining seven are from Europe. The first, second and last authors are white from sub-Saharan Africa, and are reflective on how this may influence their data interpretation, and

grateful and respectful of the critical and invaluable interpretations of the six black sub-Saharan African researcher authors. Further, in the authorship group, 10 identify as women and eight as men. We represent a diverse range of disciplines, with social science disciplines being dominant. We are a mix of early, mid and late career researchers. We wish to acknowledge the wider role of the study teams in Zambia and South Africa that contributed to data collection.

Abstract

Across sub-Saharan Africa, stigma levels have been decreasing, but not enough to achieve the 95-95-95 HIV targets by 2030. Current global HIV frameworks have identified stigma reduction, context specific interventions, and community mobilisation as critical to enabling more effective uptake of HIV services. We conducted a retrospective analysis of longitudinal qualitative and quantitative data collected in 21 urban communities in Zambia and South Africa involved in the HPTN071 (PopART) trial between 2014-2019.

We illustrate in four communities how three socio-structural features of communities intersected with stigma at the community-level: inter-group tensions, the community responses to socio-demographic change, and the local history of HIV initiatives. Tension between different social groups often functioned as a catalyst for stigmatising attitudes. Socio-demographic change at community-level took the form of rapid housing development, population expansion and outsiders moving in. The ability and willingness of a community to respond to this socio-demographic change and anti-stigma initiatives influenced HIV stigma. Our findings illustrate patterns in how community-level dynamics influence the trajectory of stigma and point towards a key strategy for accelerating reductions in stigma across sub-Saharan Africa. Community-led approaches, which take local context and dynamics into account, are critical to address the societal enablers of HIV, including eliminating stigma and discrimination. Further, stigma reduction activities should build on community HIV history, be sensitive to involuntary disclosure, speak to 'othering' linked to inter-group tensions, and be a consistent component of HIV programming, given the protection such programming provides against stigma and discrimination.

Clinical Impact Statement

To make HIV services more effective, communities need to have environments that are stigma-free and support all members to access and use these services, including people living with HIV and members of key populations. This analysis identified three socio-structural features of 21 sub-

Saharan African communities that influenced HIV stigma, drawing on four community case-studies to illustrate the pattern, namely: inter-group tensions, the response of communities to socio-demographic change (namely housing and land development, population expansion and outsiders moving in), and the historical momentum of HIV initiatives and stigma reduction activities. To ensure that HIV services take into account variations across communities, the design of such services should be community-led where possible. In addition, stigma reduction activities should be implemented consistently at the community-level, as opposed to ad-hoc or one-off interventions, and include components that contest 'othering' of groups within the community. Lastly, HIV services should be designed and implemented in a way that minimizes involuntary disclosure of HIV status.

Key words

HIV; people living with HIV; mixed-methods; socio-structural features; community

Introduction

There has been a growing recognition that environments need to be more conducive to HIV interventions for them to work effectively, and that social stigma and punitive laws are some of the critical societal impediments to such 'conducive environments' (Schwartländer et al., 2011). Conversely, a socially enabling environment that enhances the widespread uptake of HIV services includes reduced social stigma and legal recourse for discrimination. The 'societal enabling' approach became a critical component of the HIV Investment framework in 2011 and, subsequently, was incorporated into the UNAIDS 2030 targets for HIV programmes (UNAIDS, 2020). In 2022, an evidence for action framework that aimed to improve the specificity of societal enablers and better support decision making for HIV programmes was launched (Stangl et al., 2022a). Labelled the '3 S's of the HIV response: Society, Systems and Services', this framework identified the following four societal features that are critical to the HIV response: social and gender norms, inequalities, and institutional and community structures. Linked with these features, the framework articulates four 'enablers' that need to be in place to improve the efficiency and effectiveness of HIV programmes: societies with supportive legal environments and access to justice, societies free of stigma and discrimination; gender equal societies, and coaction across development sectors to reduce exclusion and poverty (Stangl et al., 2022a).

Stigma is shaped by and manifests itself within the socio-structural context. The 3 S's 'Society, Systems and Services' provide one framing of this wider socio-structural context that places HIV stigma and discrimination alongside intersecting socio-structural features (Stangl et al., 2022a). Hatzenbueler, Phelan and Link (2013; p.813) also define structural features as "the societal conditions that constrain an individual's opportunities, resources, and well-being", including other intersecting socio-structural features of race, class and ethnicity. This theoretical focus on 'intersectionality' has exposed how the role of gender, race and class intersect with HIV to stigmatise groups and identities (Logie et al., 2021; Stangl et al., 2022b; Turan et al., 2019). These

'foundationally socio-structural' (Bowleg, 2002, p.345) problems (such as racism, economic inequalities, etc.) thus need to inform multi-level HIV stigma reduction interventions to ensure equitable HIV programming and outcomes (Bowleg, 2022).

Whilst socio-structural features can be common across communities, local dynamics within environments tend to vary between communities and over time. For example, many communities can have foreign nationals residing in them, but the relationships between foreign nationals and local resident citizens can be locally determined and fluctuate. Furthermore, history, geography, and society combine in different ways in different contexts to construct stigma around social and physical differences and catalyse stigmatising processes that single out and mark those who are affected by certain health conditions, including HIV (Goffman, 2009; Parker & Aggleton, 2006; Pescosolido & Martin, 2015; Sontag, 2001). For example, in one context, certain sexual identities are considered reprehensible and made illegal, and in another context the same sexual identities are considered acceptable and legitimized. Globally, there are few empirical studies on how dynamic, contextual community-level factors impact HIV-related stigma (Tran et al., 2019), apart from research comparing urban and rural stigma in sub-Saharan Africa (SSA) (Dschaak & Juntunen, 2018; Rost et al., 1993; Yebei et al., 2008) and in places with different cultural ideologies (Krendl & Pescosolido, 2020).

In a large, longitudinal (2014-2018), mixed-methods sub-study of the impact of universal test and treatment (UTT) on HIV stigma in 21 SSA communities (12 in Zambia and 9 in South Africa) (Hargreaves et al., 2016), we collected data on how community members, people living with HIV, and health workers perceived and experienced HIV stigma (Stangl et al., 2019). The sub-study was nested within a cluster randomised trial, HPTN 071 (PopART) (Hayes et al., 2014, 2019). Our analyses demonstrated that UTT did not influence HIV stigma (Stangl et al., 2020). Other key findings from the stigma ancillary study were: a slow reduction and changes in HIV stigma over time (Stangl et al., 2020; Viljoen et al., 2021); people living with HIV being made increasingly responsible for containing

HIV (Viljoen et al., 2021); high levels of HIV stigma (Hargreaves et al., 2018); persistent judgement of key populations and young women (Krishnaratne et al., 2020, Viljoen et al., 2017); continuing fear of being seen accessing HIV services in health facilities (Bond et al., 2019; Seeley et al., 2018), and evidence that although internalised stigma increased HIV viral load (Hargreaves et al., 2020), community-level HIV incidence was not alone associated with HIV stigma (Hargreaves et al., 2022). Critically, the quantitative analyses of HPTN 071 (PopART) stigma data consistently demonstrated variability in HIV stigma measures between the 21 communities and two countries (Stangl et al., 2020; Hargreaves 2018, 2020, 2022). Variability, or the difference that made the difference, was a key area of enquiry for the broader social science design of the larger community-randomised trial HPTN 071 (PopART) (Bond et al., 2021; Bond et al., 2016), which the stigma study was nested within. A preceding mixed-methods analysis drawing on the social science data to analyse the variability of the PopART primary outcomes results (see Hayes et al., 2019), identified stability and responsiveness as two community-level social factors relevant to successfully navigating HIV, with instability and resistance contributing to communities finding it harder to successfully manage HIV (Bond et al., 2021). One component of responsiveness was a community with relatively less HIV stigma; and conversely one component of resistance at community-level was the presence of relatively more HIV stigma (Bond et al., 2021). However, in this earlier analysis, we had not analysed patterns in the variable relationship between longitudinal data of community socio-structural context and community-level HIV stigma.

Thus, this manuscript is in support of the 3 S's framework approach to embed HIV stigma and discrimination in the wider socio-structural context, to address the 'seismic gaps in knowledge' (Bowleg, 2022, p. s345) about the role of structural conditions in shaping stigma at community level (Hatzenbuehler et al., 2013; Parker & Aggleton, 2003; Tran et al., 2019; Tyler & Slater, 2018). Our analysis examined community-level dynamics that influence HIV stigma. Our intention is that this analysis can help direct the community-level focus of HIV stigma reduction interventions and facilitate enabling social environments to support HIV service uptake and utilization in the region.

Methods

Design

We conducted a retrospective, secondary analysis of qualitative data from the various data sources collected over the course of the PopART trial (see Table 1). We used descriptive, longitudinal quantitative data to consider variability in stigma over time and per community. We then considered how patterns observed in these data intersected with qualitative data on the socio-structural features of the communities to generate hypotheses about how socio-structural features of communities may influence the manifestation of stigma (See Supplementary file 1). Our ideas of how stigma and socio-structural features intersect were emergent from a detailed qualitative analysis of the specificities of each community toward hypothesis generation rather than testing. We present four communities as case studies to illustrate these patterns.

Table 1: Data Sources: HPTN 071 (PopART)*, stigma ancillary**, P-ART-Y ancillary ***

Data source	Time period	n=x	Data source
Rapid Community assessment (Broad Brush Survey)* <i>Formative research designed as rapid, qualitative data collection to describe the HIV landscape in study communities prior to the PopART trial, including gauging relevant physical features, social organisation, networks and community narratives for HIV</i> (Bond et al., 2021; Viljoen et al., 2017).	2012-2013	1202	All participants (group discussions, key informants)
		129	Community Group Discussions (group discussions, key informants)
		95	Key Informant Interviews
		203	Structured observations
Social Science: Story of the trial* <i>Qualitative documentation of intervention and research implementation, community engagement and community response throughout the intervention period. Observations, group discussions and in-depth interviews</i> (Bond et al., 2021).	2014 – 2018	263	All participants (group discussion, in-depth interviews)
		24	Group discussions
		36	In-depth interviews
		763	Observations
Stigma Health Worker survey** <i>Three rounds (denoted as R1, R2 and R3) of surveys with three cadres of health workers to assess stigma and job stress</i> (Hargreaves et al., 2020, 2022). <i>Data included in this analysis were from an open cohort of health workers who self-reported being HIV negative with complete data on all 14 stigma items</i> (Stangl et al., 2020).	2014-2018	R1: 355 R2: 315 R3: 385	Study-employed community health workers (CHiPs)
		R1: 137 R2: 287 R3: 454	Community health workers
		R1: 597 R2: 518 R3: 667	Health facility staff
Population Cohort (PC) data on stigma – Community members not living with HIV* <i>A random sub-sample of participants in each annual PC survey were selected to assess quantitative data on community level experiences</i>	2014-2018		Quantitative surveys
		4,217	PC0
		3,162	PC12
		3,714	PC24

<i>of stigma (Stangl et al., 2020). Community members not living with HIV with complete data on all 11 stigma items and ever tested for HIV.</i>		3,487	PC36
Population Cohort (PC) data on stigma – People living with HIV* <i>All PC participants at each survey who self-reported they were living with HIV to assess quantitative data on experienced and internalised stigma (Stangl et al., 2020). People living with HIV with complete data on all 11 stigma items and ever tested for HIV.</i>	2014-2018	3,825	Quantitative surveys
		3,185	PC0
		4,146	PC12
			PC24
		4,178	PC36
Qualitative stigma data on health facility space** <i>Observations at health facilities and interviews with facility health workers to assess the interaction between health facilities and stigma (Bond, Nomsenge, et al., 2019).</i>	2015	114	Key informant interviews
		31	Structured observations
P-ART-Y BBS*** combined with stigma stakeholder survey** <i>Mapping and observing services and spaces for young people (aged 10–24) in PopART communities. Structured observations prior to and during the P-ART-Y intervention that included informal discussions with young people and a qualitative stakeholder survey that included detail on stigma reduction activities linked to a component in the stigma ancillary study to document stigma reduction initiatives (Hargreaves et al., 2016; Shanaube et al., 2020).</i>	2015–2017	161	Observations
		82	Stakeholders
Community Dialogue Meetings* <i>Participatory discussions with community representatives who participated in the trial to explain and discuss the primary outcome of the PopART study and the stigma ancillary study. Only conducted in Zambia (Simwinga et al., 2022).</i>	2019	521	Participants (Zambia only)

Abbreviations include: 'R' = round, 'PC' = population cohort.

Data sources included in this analysis

Table 1 summarises the data sources used in this analysis. Further, supplementary file 24 provides an overview of the main HPTN071 (PopART) community randomised trial and the two nested ancillary studies that collectively generated the data. Each data source was available for each trial community, except for community dialogue meetings on the primary outcome results conducted in 2019, which were only held in Zambia (Simwinga et al., 2022). They are included in this analysis because of the value of the community interpretation of stigma trends.

The methods for the quantitative surveys, including design, sampling, stigma measurement validity, and completion rates have been described in detail elsewhere – see Hargreaves et al., (2016), Hargreaves et al., (2022), Stangl et al. (2020). For ease of reference, we summarise the key points here: (a) each of the quantitative surveys were open cohorts, with additional participants entering at each round, (b) community participants at each round were selected randomly, using simple random sampling techniques, while the health worker sample was comprised of a census of all health workers at the facility who agreed to participate in the 21 communities, and (c) participation rates were high. We also include details on the validated measures in supplementary file 3.

The collection of the qualitative data is also described elsewhere (see Viljoen et al., and Bond et al., 2021). Throughout the PopART trial and the stigma sub-study we used a combination of interactive group discussions, individual interviews, and observations in community and health facility settings (see Table 1). Various participant recruitment strategies were employed, including on-the spot recruitment of community members during observations, referrals, and invitations to health workers, including those employed by the trial. Amongst other topics, community members across studies were asked to describe their community, the history of the place, services - including HIV services - available, the active organisations, networks, and employment opportunities. Health workers were asked about providing services in the specific communities, the flow of patients, challenges to providing care, and the HIV history of the place.

Data analysis processes

The first and second authors are social scientists who were involved in the design of several sub-components of the trial, were familiar with the communities, are based respectively in Zambia and South Africa and participated in collecting the primary data. They systematically read through all qualitative data noted in Table 1. With the assistance of authors TM and TP, quantitative data summaries from the PC and stigma ancillary study were created for each of the 21 communities. A summary table was created where the mixed-methods data on each community were captured in narrative form from all data sources. The structure of the table was informed by a meta-indicator framework of local context (physical features, social organisation, social networks and community narratives) linked to the Broad Brush Survey approach (Bond, Ngwenya, et al., 2019) and by features of particular significance to HIV based on the literature and our own analysis (Bond et al., 2021). As a final step, concise summaries of the interactions between socio-structural features and stigma in each community were added, working across the data in the community. Co-authors familiar with the communities, the trial, and data collection processes verified the table content.

For the quantitative data, we explored with standard descriptive statistics (means, distributions). We compared community level data to the geometric mean across all 21 communities to allow us to gauge if stigma was relatively high or low in a particular community. We used these descriptive analyses to orient our analysis of the qualitative data. We were not seeking to examine statistical associations between community or participant characteristics and changes in stigma over time. Another analysis is currently underway to quantitatively assess the factors associated with change in stigma measures during the trial across all 21 communities.

Ethics

The HPTN 071 (PopART) trial, including all sub-components and ancillary studies, received ethical approval from the University of Zambia Bio-Medical Research Ethics Committee, the London School of Hygiene and Tropical Medicine Research Ethics Committee, and the University of Stellenbosch

Health Research Ethics Committee. Governmental health authority clearance was also obtained in South Africa and Zambia. All study participants who were interviewed provided written informed consent as per the local Research Ethics Committee guidance. For structured observations we obtained verbal consent from participants and community leaders.

In this analysis, we use codes (ZA = Zambia, SA = South Africa and numbers 1 through 4 - ZACom01, ZACom02, SACom03, SACom04) to protect the confidentiality of places and people. In our case descriptions, we aimed to provide detailed descriptions of each of the places without disclosing the location or name of the communities. We tried to balance, as Vorhölter (2021, p. 16) described, “respecting research participants’ interests and well-being ... and living up to both the high ethical standards of the discipline and the desire to provide a meaningful analysis of ‘real’ issues, people, and places”. We did this by excluding identifying information such as the names of major roads, rivers, towns, and by describing places in general terms while still including sufficient detail to provide a comparative overview of each community.

Findings

We first present the longitudinal quantitative stigma data (2014-2018) in graphs (see Figures 1 to 3), across three groups (community members, PLHIV, and health workers) and the four selected case-study communities. In the graphs we compare community specific stigma outcomes with the geometric mean (represented by the following symbol - \diamond) across all 21 communities. In the following analysis, we then focus on three community features that we identified as shaping the dynamic interaction between socio-structural features and HIV-related stigma across communities. We describe the relationship between these features and HIV stigma, using illustrative examples from the four case studies and quantitative data patterns described. We then present the convergence of these features alongside stigma. A summary of the key socio-structural features of each of the four communities is presented in supplementary file.

Figure 1: Community Level Stigma Outcomes across communities, 2014 to 2018.

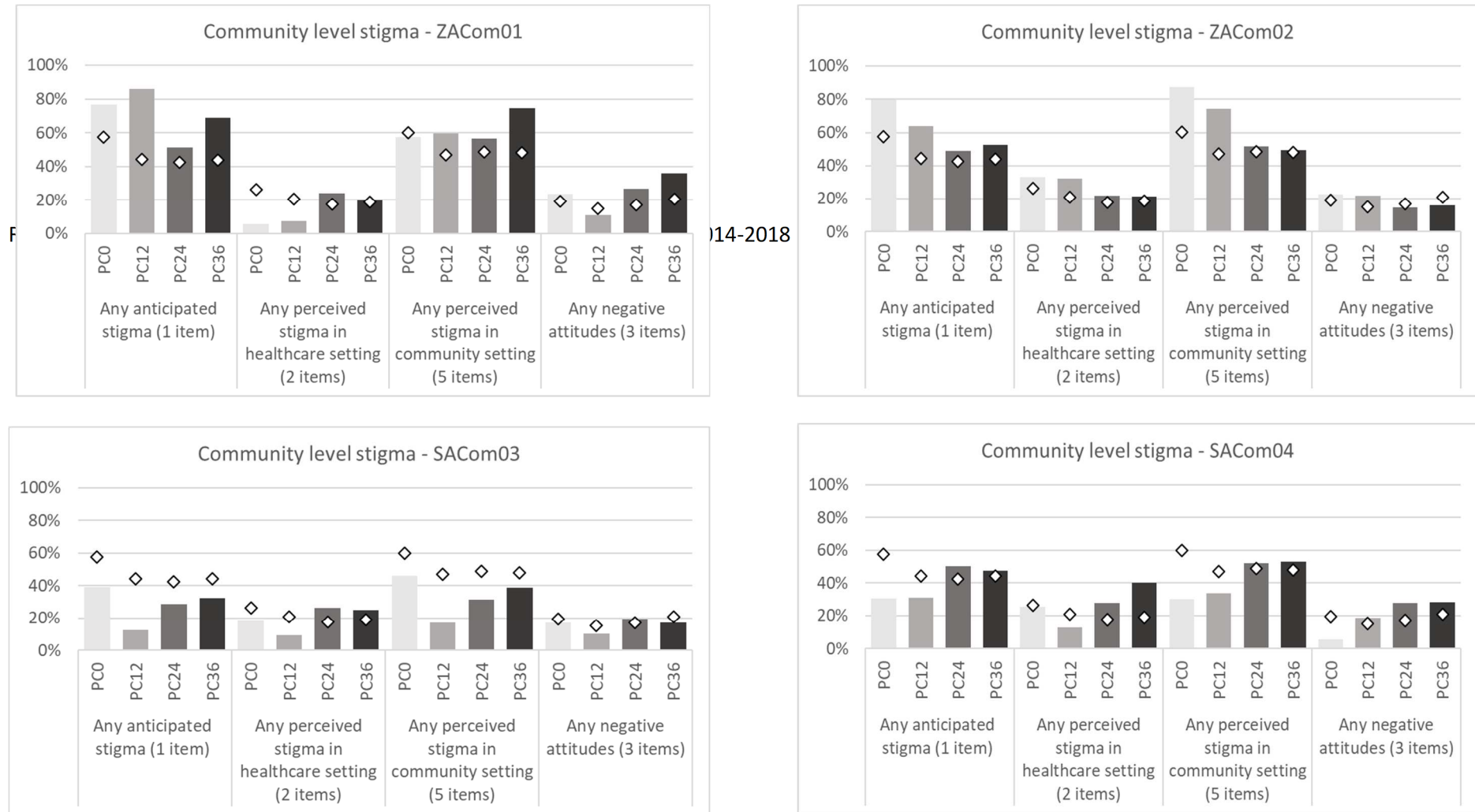


Figure 2: Stigma reported by people living with HIV across communities, 2014-2018

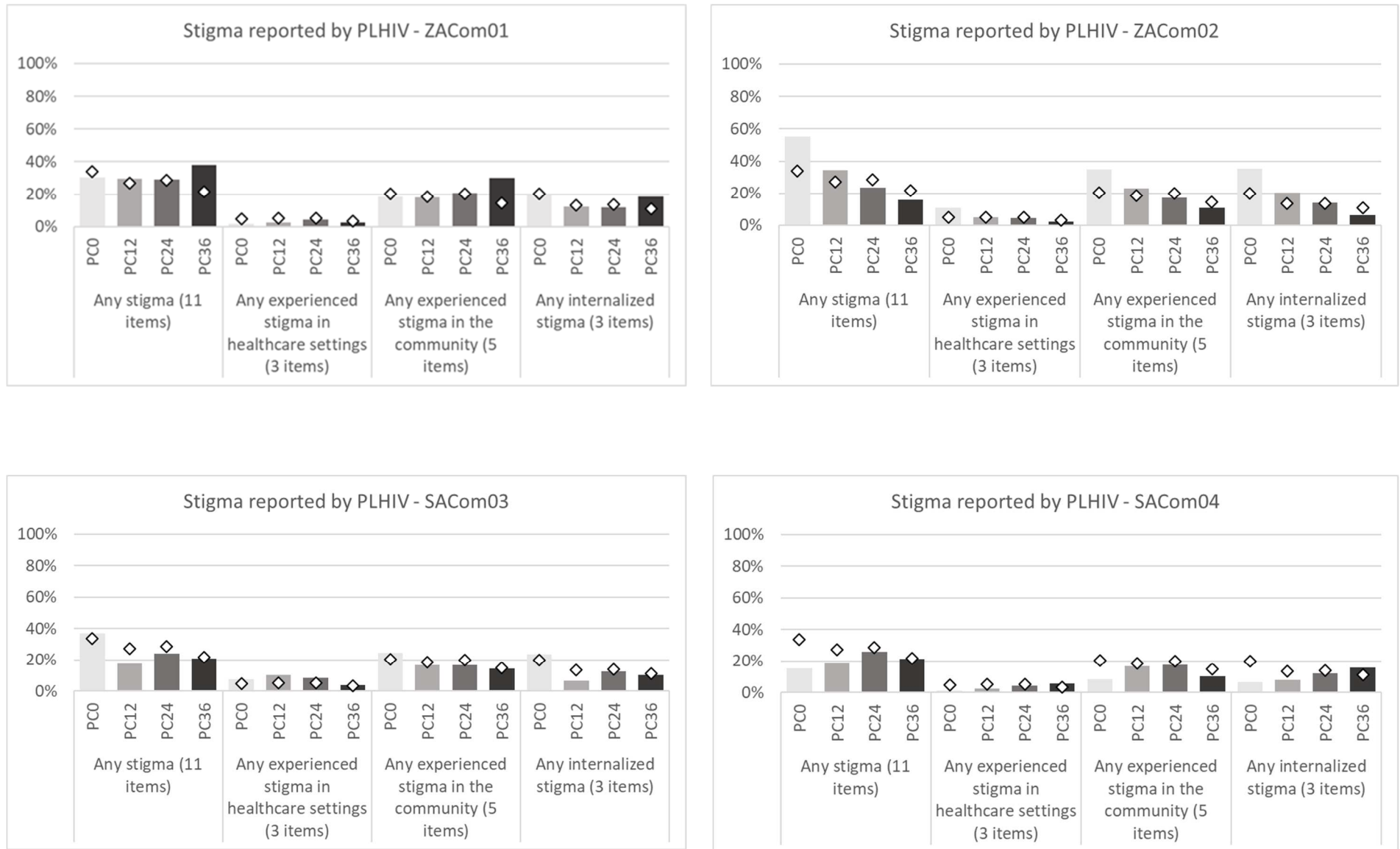
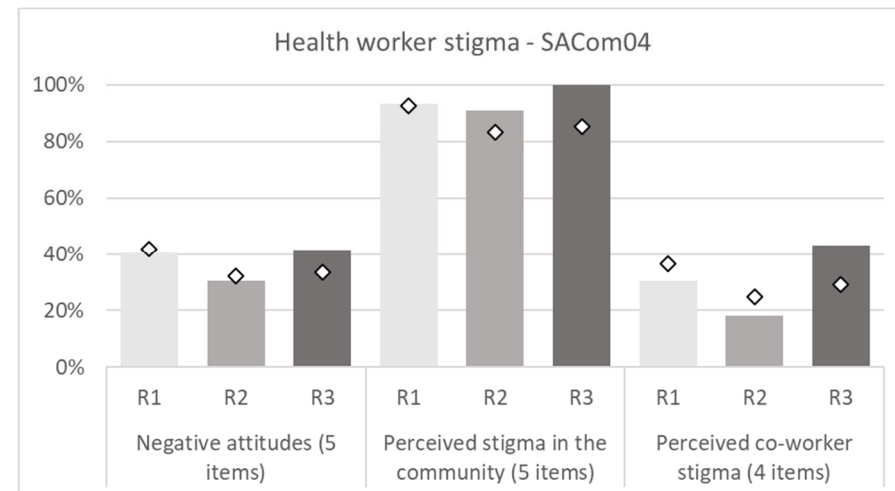
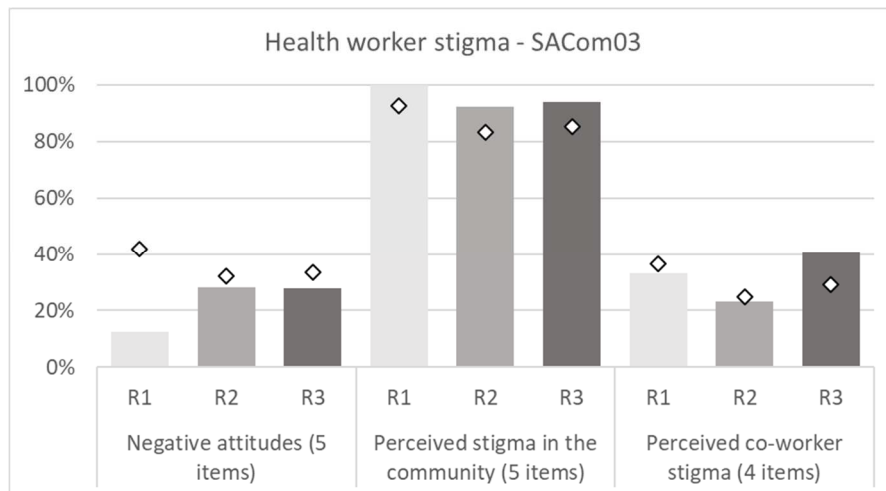
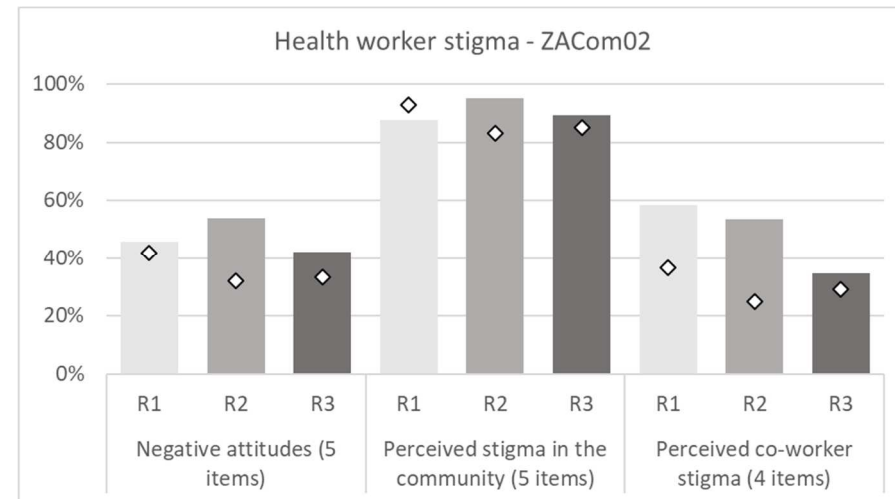
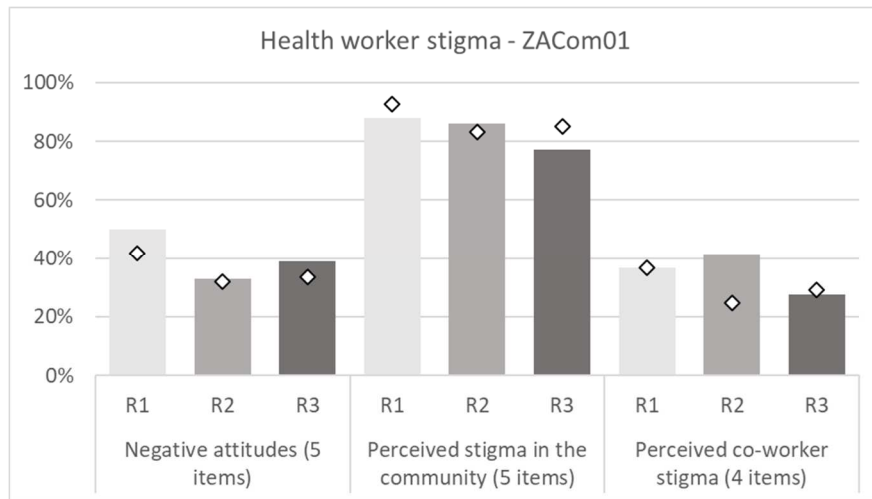


Figure 3: Health Worker stigma outcomes across communities, 2014 to 2018



Interactions between socio-structural features and community stigma

Inter-group tensions

Tension between different social groups, insiders and outsiders, between racial or cultural groups or between social classes, often functioned as a catalyst for stigmatising attitudes. Who the social tensions were between, and the level of social tensions, varied across the four communities and over time. However, residents in all communities described how both women and young people were often blamed for HIV transmission, reflecting that these patterns of blame are linked to wider socio-structural features beyond the community-level. To illustrate, it was not easy in any community to be open as a young person living with HIV. Community members would refer to young people as generally lacking morals and therefore more likely to transmit HIV. Regarding women, there was a tendency to label women living with HIV as “*prostitutes*”.

For example, in SACom04 perceived community stigma was 30% in PC0 and 53% in PC36. Similarly, overall stigma experienced by PLHIV was higher at each round than the preceding. Notably internalised stigma was 7% at PC0 and 16% at PC36. In other communities, on average, internalised stigma was higher at PC0 than at PC36. In the qualitative data, we observed tensions between insiders and outsiders were especially evident in SACom04, a general distrust of ‘outsiders’ extended to initial negative perceptions of the study-employed community health workers. In addition, community members described how racial tension and silences around HIV meant that blame for HIV and transmission were attributed to newer residents.

In relation to tensions between social classes, ZACom02 is an interesting contrast to ZACom01 with ZACom02 mostly assimilating a new middle-class moving into the community and ZACom01 residents reportedly resenting a longer established pattern of middle-class movement into the community. This demonstrates how different communities can respond differently to the same

event. ZACom01 is distinctly divided into the poor, who live in an unplanned area, and the better off, who live in a planned area. ZACom01, with a more established mixed socioeconomic status profile, also has a more robust local economy in contrast with ZACom02. The better off in ZACom01 tend to blame residents of the unplanned area for giving ZACom01 “*a bad name tag*” and for disease, misfortune, and low literacy levels. Indeed, community member quantitative stigma measures in ZACom01 mostly increased over time. For example, negative attitudes (centred on fear and judgement) rose from 24% to 36%. Also, in ZACom01, PLHIV and health workers perceived and experienced higher stigma over time, reflecting a similar pattern to SACom04. In ZACom02, there was mostly a steady and steep reduction in community member stigma outcomes over time. For example, there was a decline in perceived community stigma from 87% in PC0 to 49% in PC36, while anticipated stigma reduced from 80% in PC0 to 52% by PC36, with a slight rise in anticipated stigma and negative attitudes in the final year of the trial. The latter could indicate rising social class tensions similar to those manifested in ZACom01. In the community dialogue meeting in 2019, when asked to provide their own explanation about increased stigma reported by PLHIV, ZACom01 participants pinpointed increasing numbers of wealthier outsiders moving into the community holding stigmatising attitudes and increasing both social tensions and pressure on the local health facility.

In SACom03, the social profile was relatively homogeneous, with most residents being black, Xhosa speaking, younger and from a lower socioeconomic group and with a small minority of other African nationals and ethnicities. Quantitative stigma patterns varied overtime throughout the trial until the final year when most measures increased. This variability reflects a sense that potential underlying events were impacting on the community. According to foreign nationals, there was xenophobia towards other Africans, reflecting the suspicion and caution of residents and the fragility of SACom03 as a place to live. However, PLHIV experiences of stigma in the community decreased over time from 25% in PC0 to 14% in PC36 which could imply that the chaos and newness of SACom03

could provide a context where it was easier to be more anonymous as a PLHIV and thereby experience less stigma.

Socio-demographic change

Rapid social change and development, in the form of outsiders moving in and change in housing and/or expansion on undeveloped land, were identified as key factors influencing HIV stigma. All four communities encountered varied degrees of change. In SACom03, the most extreme change preceded the trial period, with farmland being replaced by informal housing, new service infrastructure and government housing from 2003 onwards. However, SACom03 experienced fewer changes during the trial period. In the other three communities, rapid social change occurred during the trial, with community housing and population expansion and increasing social diversity.

ZACom01 had a more gradual and subtle change that dated back to the expansion of the Zambian middle-class from the early 2000s and their purchase of land in high-density areas to build their homes. Community members described how, during the trial, this newer middle-class was still moving into ZACom01, buying land, and building large houses. The change in ZACom02 and SACom04 was more evident. Transforming from a district town to a provincial capital, ZACom02 was caught up in profound change as civil servants, services and other outsiders moved in. In SACom04, residents described how the community was subject to a persistent sense of upheaval, with an influx of new community members, buildings being demolished, and new neighbourhoods being erected almost overnight.

ZACom02 exemplifies change being regarded as a positive development. Residents described how ZACom02 was historically a closed, homogenous, and suspicious community, with strong, conservative leadership. As the town transitioned to a provincial centre, ZACom02, which is located very close to the town centre, altered to a more open, bridging community with extensive networks and open to assimilating outsiders. During the trial period, the accompanying change was largely welcomed since it was perceived as boosting a poor community, bringing employment possibilities, a

demand for a range of services and housing and the hope of better prospects. Although the change to becoming a provincial centre made the community more congested and chaotic, this established community had the leadership, infrastructure, and the land, to accommodate the development. In this change context, stigma measures amongst community and PLHIV were high at the start of our measurement and decreased consistently and steeply over time. For example, any experienced stigma in PLHIV had the largest reduction over time across all communities, falling from 35% in 2014 to 11% in 2018.

By comparison, participants noted how change was not welcomed in SACom04 by longer-term residents. The scale of social change and development in SACom04, like ZACom02, was also dramatic and rapid. Likewise, residents described SACom04 as an established, closed and historically homogenous community, suspicious of outsiders. Although participants often identified religion, family, and patriarchy as strong influences, there were no clear leadership figures. Stigma measures across all groups started lower than the average across all 21 communities. During the trial period, informal housing units were replaced by government residential development programme housing and farmland was acquired for house building. This transformation was accompanied by an inflow of people identified by residents as being from different ethnic/language /national groups. The longer established enclave of residents was slightly more affluent and, according to participants, did not embrace the rapid change to their community. Over time, stigma outcomes increased across all groups, and particularly community measures, for example, perceived community stigma increased from 30% in PC0 to 53% in PC36. There were strong narratives of blaming reported by community members, where 'outsiders' were associated with HIV and disease transmission. The increase in stigma in SACom04 thus sharply contrasts with the response to a similar significant influx of newcomers and landscape transformation in ZACom02 in a similar time period against a backdrop of respectively lower (10.8% in SACom04) and higher HIV prevalence (28.1% in ZACom02).

In ZACom01, the shift to having more middle-class residents was not a welcome development although this demographic shift was part of a gradual trend. ZACom01 was a vibrant community and a recipient of broad-based development manifest in the presence of many active non-governmental organisations (NGOs). ZACom01 also had a strong history of the dominant lower socio-economic class residents voicing their grievances. There was also reportedly a concerted effort by some community members during the trial period to shake off a reputation for criminal activity, extreme poverty, and alcohol abuse. Indeed, during PopART, ZACom01 was becoming even more developed and safer. Nonetheless, this growing sense of security did not reflect in ZACom01 community stigma outcomes, which were higher at the end of the trial than at the beginning, increasing in three measures over time (health care setting, community perceived stigma, negative attitudes) and higher than average for anticipated stigma. For example, anticipated stigma was reported by 77% of participants in PC0, and 68% in PC36 compared to an average across all 21 communities of x%, and x% in PC0 and PC36, respectively. Observation data also reflect some community stigma, including a reported resistance amongst residents to HIV testing and accessing ART within the community and a concern about trial community health workers (CHWs) visiting households in uniform. Additionally, PLHIV described a fear of name-calling and of others knowing that they had HIV through their daily ART treatment regimen, which resonates with the observed increase in experienced (from 18% in PC0 to 30% in PC36) and internalised PLHIV stigma outcomes over time in ZACom01. Therefore, it appears that largely unwelcome socio-demographic change compounded an undercurrent of community sensitivity to stigma.

History and momentum of HIV initiatives and stigma reduction activities

Active anti-stigma initiatives emerged as stigma buffers in community settings. Despite the long history of activism in South Africa, stigma stakeholder activities during this study period were often less evident in South Africa than Zambia. For example, in SACom04, although a few organisations were identified as providing HIV services (educational health talks and patient support), they were

not very visible on the ground and none was reported to be implementing stigma reduction initiatives. Similarly, in SACom03, although there were community initiatives such as gardening and sewing clubs, only one NGO was identified, and many CHWs had to be brought in from other areas. Hence, in both communities, there was a lack of active organisations to educate and shield community members from negative expectations related to HIV. According to participants in SACom04, the PopART intervention was not initially welcomed, reflecting resistance to outside intervention, with multiple engagement activities conducted to enhance acceptance. Internalised stigma for PLHIV increased from 7% in PC0 to 8%, 12% and 16% in PC12, PC24 and PC36 respectively. Similarly, anticipated stigma among community members increased from 30% in PC0 to 48% in PC36 in SACom04. Whilst PLHIV did not report any increases in experienced stigma over time in SACom03, perceived community stigma scores were inconsistent, starting at 39% in PC0, steeply reducing to 13% in PC12 and rising again to 29% and 32% in PC24 and PC36 respectively.

With many more active NGOs working in the HIV space, the two Zambian communities are strikingly different to SACom03 and 04. Dating back to the late 1980s, there is a long history of HIV initiatives in ZACom02, including a national counselling and testing NGO, home-based care, and church activities. In 2015, other than the health facility and PopART, there were nine active HIV stakeholders, including the Network of Zambian People living with HIV (NZP+). Focal populations for outreach and services were mainly community leaders, PLHIV, orphans and vulnerable children, sex workers and youth (in and out of school). Across community and PLHIV stigma outcomes, and most health worker outcomes, there is a consistent pattern in the ZACom02 quantitative stigma data that reflects comparatively high levels in 2013-14 with a steep decline over time to relatively low levels in 2018 amongst PLHIV and community members. During the community dialogue meeting in 2019, PLHIV in ZACom02 were notably vocal and open. Meeting participants attributed the decline in community stigma (that was shared with them as part of the dialogue approach) as partly due to a recent programme of anti-stigma education activities in churches. Indeed, compared to other Zambian communities, there was an unusually high number of direct stigma reduction activities

carried out by HIV stakeholders in ZACom02 during the trial. These activities included HIV-related stigma education, sensitisation and awareness embedded in broader HIV programmes, and more direct stigma reduction activities. Examples of these were: NZP+ conducting group discussions on stigma with PLHIV and using visuals to teach people in the community about stigma; a youth outreach programme promoting interactions with young PLHIV; and a school encouraging young PLHIV to take part in different activities to challenge discrimination.

There is also a long history of HIV initiatives in ZACom01, dating back to home-based care in the early 1990s. In 2016, there were 16 HIV stakeholders with different activities. Reportedly, the PopART intervention became more acceptable over time, although it was sometimes confused with other stakeholder initiatives. Further, according to community members, gossip about PLHIV was linked partly to trial CHWs conducting follow-up household visits. The quantitative data show healthcare workers and PLHIV perceiving and experiencing higher stigma over time with community stigma mostly increasing over time. Although there were no anti-stigma education initiatives, an event in 2016 illustrates the capability of ZACom01 residents to recognise and act against stigma. Participants told how a new HIV initiative was conducting HIV testing in markets and households in the community. Reportedly, all those who tested HIV-positive were put on a bus to be taken to a health facility and initiated on ART. A community advisory board member explained that *“this increased the rate of stigma as community members recognised people in the bus and this created problems until the NGO was told to stop”*. Some residents assumed this initiative was linked to PopART and said that this incident had undermined trust in the trial CHWs.

Intersections of socio-structural features alongside stigma

As evident from the preceding analysis, all three features (inter-group tensions, socio-demographic change; history and momentum of HIV initiatives and stigma- reduction activities) interacted with each other and stigma. Therefore, no one socio-structural feature could be understood on its own. For example, in ZACom02, a combination of features combined to push stigma down over time:

positive development in the wake of an influx of civil servants that boosted the local economy, a strong history of HIV initiatives (including stigma reduction activities), trust in the health facility, and structural adjustments at the facility (for example, building the ART clinic in a place that provides more privacy for clients). Other convergences are less straightforward, with some features pushing stigma up and others down. Hence in ZACom01, although development exposure and community voice facilitated an ability to act against stigma, social tensions were evident between a distinct new middle class moving in and building in the community and the majority, lower socio-economic status residents, and this tension pushed stigma up. In SACom04, stigma was pushed up by an influx of new residents, tensions between insiders and outsiders, and an overall distrust in the health facility. Alternatively, erratic stigma patterns across groups and domains in SACom03, reflected community disorder in this newly established community settling after a period of extreme disruption and lacking social cohesion.

Additionally, some features carried more weight in some communities than others. For example, social change was a less powerful driver of stigma in ZACom01 than social divisions. In SACom03, the instability and newness of the place made it easier for stigma to slip through the net of what needs to be acted on. With mostly younger, Xhosa families as residents who were less focused on HIV and more on hustling for employment and adjusting to their new life in Cape Town, stigma often surfaced. Furthermore, in SACom03, the absence of leadership also made stigma harder to address. In SACom04, the divisive features were stronger than the consolidating features and fuelled stigma. In ZACom02, the features that matter to pushing stigma back are at the fore. Hence, the convergence of features and stigma can be quite nuanced.

Discussion

We show how community-level features can impact on how HIV stigma manifests, explaining, in part, variability in quantitative stigma outcomes across communities and speaking to a gap in the understanding about the relationship between socio-structural features and stigma over time (Tran

et al., 2019). We use mixed-methods, longitudinal stigma data from 21 urban communities in South Africa and Zambia to tell the story of a place, and a story of stigma in that place. We found that three features of communities intersected with how stigma manifests: inter-group tensions, socio-demographic change, and the historical momentum of HIV initiatives and stigma reduction activities. We demonstrate that these features interact with stigma in unique and dynamic ways. Our analysis highlights the importance of community structures, one of the four societal features of the 3 S's framework, and suggests that a more nuanced investigation of key community features is needed to facilitate an enabling environment for HIV programmes.

Social tensions between different types of groups varied in four case study communities. 'Othering' of groups is a key driver of HIV stigma (Joffe, 2011). Moreover, tensions not related to HIV have been established as generating distrust that spills over into stigmatising attitudes, especially towards key populations whose shared identity is already stigmatised (Pantelic et al., 2019; Turan et al., 2019). In a South African context, for example, distrust is linked to the history of apartheid and the accompanying racism and hierarchy where diversity was not always embraced (Airhihenbuwa & Webster, 2004; Petros et al., 2006). In our data, social tensions between different groups (insiders and outsiders, ethnic groups and social classes) could exacerbate stigma, especially if social groups were distinct (socially and spatially), not desired, and if the community was more fragile. Higher levels of stigma were linked to distrust of others and inequities between groups. The latter displays the tendency of stigma to unfold in contexts of social inequality, unequal power and dominance (Link & Phelan, 2001; Parker & Aggleton, 2003). In efforts to address the normalisation of HIV and reduce HIV stigma across different HIV prevalence contexts (Abrahams et al., 2004; Camlin et al., 2020; Chan et al., 2015; Visser et al., 2009), there needs to be a stronger emphasis in stigma mitigation programmes on addressing the tendency to blame HIV on other groups (Chan et al., 2015; Persson, 2013; Petros et al., 2006). As Petros et al. (2006) remind us, we need group focused interventions that look at this problem of 'othering' and complex social dynamics to effectively reduce HIV stigma.

There is a lack of literature that links socio-structural changes at community-level to shifts in HIV stigma in sub-Saharan Africa. Exceptions are how the end of apartheid in South Africa and the accompanying positive shift to embrace cultural diversity had the potential to enable reduced stigmatisation between groups (Airhihenbuwa & Webster, 2004). Also, in rural Tanzania, modernity was a structural change associated with acquiring HIV and linked to some changes in stigma (Roura et al., 2009). In our analysis, the scale of social change, combined with community ability and willingness to respond to change, influenced HIV stigma. Change, in the form of outsiders moving in, land expansion, and housing development, occurred in all four case study communities. If change was welcomed, and if a community was socially cohesive, stigma reduced over time. Extreme change manifested in swings in stigma over time if a community lacked social cohesion. If communities resisted change, stigma could increase over time, although the type of stigma that increased depended on other socio-structural features, such as community members' ability to recognise and act against stigma (exemplified by ZACom01) and social homogeneity (exemplified by SACom04). Further, communities where there was rapid change suggest that attitudes could also rapidly change and could lead to quantitative stigma measures being erratic, as exemplified in SACom03.

It was evident from ZACom01 that social cohesion within a more oppressed majority group could push community member stigma linked to social tensions down, although stigma experienced by PLHIV overall remained more sensitive to social tensions and increased if social tensions were heightened. This is a stark indication of the importance of community mobilisation and resistance to HIV stigma and discrimination (Campbell et al., 2005; Li et al., 2018; Mburu et al., 2013; Parker & Aggleton, 2003). In an African regional qualitative stigma study, everyday stigma was linked to absent supportive community discourse (Bonnington et al., 2017). Although it was hoped that HIV education alone could reduce local stigma (Roura et al., 2009), our analysis indicates that a deeper shift and degree of community acceptance is needed for PLHIV to feel accepted and have the freedom and strength to resist and reduce stigma. This underscores the importance of community-planned and -led actions to reduce HIV stigma and discrimination (Campbell., 2005) that take into

account how stigma compounds the negative experiences of PLHIV. Although both SA communities had lower stigma at the start of the trial, which might in part reflect the cumulative effect of earlier HIV activism in South Africa (Squire, 2013), in the four case study communities in this analysis, there were fewer HIV initiatives on the ground in South Africa compared to Zambia during the study period. There were also strikingly few specific stigma reduction activities in the communities, with the exception of ZACom02. Our findings resonate with other literature (Bonnington et al., 2017; Campbell et al., 2005; Roura et al., 2009), showing that active HIV initiatives with specific stigma reduction components, and particularly those that involve direct activities bridging and facilitating contact between PLHIV and the broader community and challenging discrimination, broadly reduced stigma. This underscores the need for everyday advocacy and accepting discourses (Bonnington et al., 2017), the meaningful involvement of PLHIV in HIV initiatives to address structural stigma (Brown et al., 2022) and reinforces the need to consult with local residents before implementing programmes.

However, both negative responses to household contact with the PopART trial CHWs across both intervention communities and an event with a HIV initiative relayed in ZACom01, serve as a reminder that HIV initiatives can also contribute to increasing stigma. The unintentional impact of HIV programmes and service models in sub-Saharan Africa in increasing HIV stigma is evident in other studies. For example, Wringe et al. (2010) raise their concern that women are more likely than men to be diagnosed with HIV through routine health care access and through HIV programmes, resulting in women bearing the brunt of HIV stigma. A recent commentary (Golub 2022) argues that HIV programmes can unintentionally trigger one or more of Link and Phelan's (2006) four components of the process of stigmatisation (labelling, stereotyping, separation, and status loss and discrimination) to activate stigma, overlooking the intersection of power and oppression. For example, PopART trial CHWs visiting households and conducting follow-up visits were said by some participants to have inadvertently labelled and stereotyped individuals and households, unintentionally triggering HIV stigma.

As Hatzenbuehler et al. (2013) remind us, stigma needs to be considered alongside other life domains and the contribution of structural factors to stigma is often ignored. Pantelic et al. (2019), in reference to internalised stigma, show how social and structural determinants of health shape and limit health and well-being, further arguing that these determinants all evolve over time, are culturally embedded and interlocking, and influence stigma as they evolve. Our analysis highlights how HIV stigma dynamics are better understood alongside local context, as well as demonstrating the convergence of socio-structural features and stigma. Usually, no single socio-structural feature is isolated from others and stigma sits alongside the unique convergence of features in each place. Stigma can be pushed up and down, and back and forth by these combined features; it is how the puzzle fits together in each place that matters for stigma. Hence, a shift in context itself is needed to provide a mechanism for pushing stigma down. We need policies and interventions that address the social factor itself (for example, promoting contact with PLHIV) and, as pointed out above, avoid producing new mechanisms for increasing stigma (Hatzenbuehler et al., 2013).

In Table 2, we present examples of tailoring stigma-reduction to community socio-structural features in the four case-studies to demonstrate our argument.

Table 2: Examples of recommendations for Tailored Stigma Reduction initiatives

Community	Inter-group tensions	Community response to socio-demographic change	History of HIV initiatives
ZACom01	Tailor stigma reduction approaches of 'othering' to tensions between classes to build trust & co-create anti-stigma activities.	Concerted effort to build bridges between new, middle class and lower socio-economic class, and include middle class in HIV initiatives.	Build on strong HIV programme history & development initiatives, and introduce more stigma-reduction specific initiatives including in churches and PLHIV support groups.

ZACom02	Directly address sex worker and adolescent girl HIV-related stigma in health facilities & community.	Engage civil servants and accompanying businesses directly in anti-stigma initiatives, working with church & political leadership.	Extend & continue history of stigma-specific initiatives, promoting these as a good example of effective action against community stigma.
SACom03	Address tensions between foreign nationals and local residents	Build on existing acceptance of diversity with continued general anti-stigma training to pre-empt emerging stigma	Partner with existing NGOs/clubs to establish stronger HIV-support networks and anti-stigma initiatives
SACom04	Expanded anti-stigma activities across different enclaves of the community to address insider/outsider divide	Continued engagement with the existing community as new housing is added	Work with existing HIV-service providers and organisations to include anti-stigma initiatives

Limitations

We do not analyse the quantitative trends statistically in this analysis, choosing rather to respond to the increases and decreases in stigma measures across three groups over time, within and across four communities chosen as case-studies. This requires a leap of faith for more quantitatively inclined readers, and we acknowledge this as a quantitative limitation. Another limitation is that we have provided evidence for patterns in a relationship between socio-structural features and HIV stigma, but have not explicitly furthered theoretical thinking about the stigmatization process, choosing instead to provide pragmatic direction for approaches to reduce or mitigate HIV stigma. Additionally, although we identified the three patterns across all 21 communities, we do not demonstrate this, rather focusing on four communities as case studies to illustrate the patterns in more detail. The dynamics in other communities would be different in degree and convergence, but the case studies included highlight the unique community dynamics that are critical to understand in order to shape stigma mitigation efforts.

Conclusion

The complexity of the local dynamics of both socio-structural context and HIV stigma have made stigma harder to research and more challenging to address. Often the significance of the quantitative variability in stigma data across communities remains unanalysed, as researchers tend to investigate factors associated with trends over time across large populations (i.e., regions or nations). We used a unique opportunity to combine longitudinal qualitative and quantitative stigma and socio-structural community data to identify any patterns in community socio-structural and stigma variability over time, targeting a gap in the understanding about this critical relationship. Three features of communities, independent of the HPTN 071 (PopART) intervention, emerged as intersecting with how stigma manifests: inter-group tensions, community response to socio-structural change, and the historical momentum of HIV initiatives and stigma reduction activities. These features interacted alongside stigma in unique and dynamic ways, with shifts in local feature dynamics increasing or decreasing stigma, and often not directly either just impeding or enabling stigma. The implications of this analysis for HIV programmes and addressing the societal enablers (Stangl et al., 2022a) are: to build on local community momentum and history of addressing HIV and stigma, recognise that each community has a unique combination of features that push stigma up and down, be wary that interventions that identify PLHIV can trigger stigma (Golub 2022) and to contest 'othering' of groups. This contextual and stigma tailoring of HIV services and programmes could be achieved through rapid qualitative assessments of HIV history and options (Bond et al., 2021), community-led monitoring (Baptiste et al., 2020; Makoni et al., 2022), and the inclusion of stigma reduction as core outcomes of programme implementation (Golub, 2022).

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Supplementary material

[Supplementary file 1](#)

Table 1 Data analysis matrix for ZACOM01

Place: ZACOM01 HIV Prevalence: 17,4% HIV Incidence: 1,6%			
Open/closed: Open		Responsive/resistant: Mixed	
		Stable/unstable: Unstable*	
Stigma data			
Stigma quant: Community members	Stigma Quant: PLHIV	Stigma Quant: Health workers	Stigma qualitative
<p>Anticipated stigma: Started at 77% in PC0 then rose to 86% in PC12 and fell to 52% in PC24 and settled at 68% in PC36 (higher than average overall, pattern similar except for rise in P12 as opposed to average drop). Health care: Began at 6% and increased to 8% in PC12 then increasing steeply to 24% and falling slightly to 21% in PC36 (lower than average at first then similar to average in last two years). Community stigma: Began at 57% in PC0 then rose to 60% in PC12 and fell to 57% in PC24 rising at 75% in PC36 (slightly lower at beginning, notably higher than average at end). Fear and judgement: Began at 24% in PC0 then fell to 11% in PC12 and rose back to 27% in PC24 and higher to 36% in PC36 (similar to average, except slightly lower in PC12). Summary: Except for anticipated stigma, all measures are higher at the end than at the beginning (compared to average where most measures are lower except negative attitudes), and other than negative attitudes, does not mirror an average</p>	<p>Any stigma: Was constant at 30% in PC0 and PC12 then fell slightly to 29% in PC24 and increased to 38% in PC36. Internalised stigma: Began at 20% in PC0 then fell to 12% in PC12 and PC24 and increased to 19% in PC36. Experienced stigma: Began at 18% in PC0 and PC12 then increased to 21% in PC24 and further to 30% in PC36. Health care: Generally, very low, started at 2% in PC0 and PC12 then increased to 4% in PC24 and fell to 3% in PC36. Resilience: Started at 15% in PC0 then increased to 17% in PC12 and fell slightly to 16% in PC24 and rose to 23% in PC36. Summary: Pattern of falling a bit then rising, and compared with average, measures (any stigma, enacted stigma, internalised stigma) are higher at the end, except for health care stigma. Any stigma ends higher (8% increase v 12% drop). Internalised stigma is similar to average then 9% increase v 10% drop. Experienced stigma is similar to average but there is a steady increase by 12% (v 5% fall). Health Facility stigma is very</p>	<p>Co-worker stigma: Began at 36% in R1 then increased to 41% in R2 and fell to 27% in R3 (similar in R1 and R3 but higher in the middle to average). Community stigma: Began at 88% in R1 and R2 and falling slightly to 77% in R3 (similar to average except average slightly higher in R3). Personal attitudes: 50% in R1 dropping to 32% in R2 and increasing to 39% in R3 (similar to average, slightly higher at beginning and end). Summary: Overall, there is a fall in health worker measures over time & pattern very similar to average.</p>	<p>Blaming: Strong blaming tendency focused on one group. Unplanned area 'blamed' for disease and crime by those in planned area. Alcohol abuse in 'shebeens' in unplanned area blamed for everything including illiteracy. Clinic: because of stigma at the clinic people also test outside of the community. Concerns about HIV stigma & possibility of confidentiality breaches at clinic through CHWs during BBS & HIV stigma was said to need addressing. Quite a number of nicknames including 'topping'. NGO colleague said no-one would test for HIV at a tent because people do not want to be seen. Study-employed community health workers reduced stigma, but it is still there. Young people do not talk about adolescents LHIV. Facility lay-out: Services demarcated & ART clinic visible from the gate. PLHIV can be easily seen from facility. PLHIV can be seen from the gate when they collect drugs from the pharmacy. Usually congestion, PLHIV talk about what makes the process so slow.</p>

<p>drop in PC12 across measures. Community member stigma increased in three measures over time (health care, community perceived stigma, negative attitudes) and dropped but was higher than average for anticipated stigma.</p>	<p>similar to average although slightly lower than average at beginning.</p>		<p>Visible posters for HIV guidelines. Files and slips show HIV status. Clinic structure changed during PopART with out-patient department and ART building being completed. Wall (not full height) erected around ART clinic waiting area to avoid identification of PLHIV during intervention and based on PLHIV requesting for this wall and the clinic staff deciding this should happen & getting funding. The “wall speaks volumes”. ART packaging in bins and pills in handbag/ plastic.</p>
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Community

Physical	Networks	Social Organisation	Comm. Narratives
<p>Housing: 3/4s very poor, unplanned, dense housing. 1/4 newer, planned, closer to amenities. Work: informal, veg farming, construction, entrepreneurial, criminal, formal jobs outside for a few. Physical boundaries: close to town centre, stream running through, one health facility within, no secondary school, two markets, two football grounds. Ethnicity mixed, few foreign nationals. Age: mixed, elderly born there. Large population. Class: mostly lower SES, very poor, some new middle class moved in & built new housing.</p>	<p>Two groups - social inequity within between poor and new middle class, tension between these two groups. Networks extensive in some ways - Young people enterprising, NGO presence very strong, HIV testing in tents, sex work evident, trading a way of life. Intensive in other ways: Voluntary Male Medical Circumcision (VMMC) resistance, mistrust of clinic, HIV rumours, faith healing strong. But mistrust of clinic, HIV Self-Testing, Community Health Workers, to be replaced by trust. Traditional Healers open to being approached. Social capital bonding between generations & lower class, pride in place, open to intervention, but divided by new middle class. Boundaries mainly fixed.</p>	<p>Population clearly divided between poor in unplanned housing & better off in planned housing. Mainly informal work - vegetable farming significant. Very close to town - walk/bike in. Many NGOs, CHWs strong & active. Many HIV services nearby and within. Population very mobile on a daily basis - sex workers rent locally & go to town as well as clients within town. Many bars, vegetable farmers with plots or market in town to sell. Secondary school children move out to school. Community empty/quiet during the day - more people in than out. Middle class hard to reach.</p>	<p>It is an open and vibrant community with pride in the place. Strong social divisions between ‘planned’ and ‘unplanned’. Legacy of crime although becoming safer and NGOs very active. Alcohol abuse pronounced. Degree of chaos and fear. Resistant initially but open to change. Local identity strong amongst lower SES but hard to identify local gate keepers. Unplanned area. Event later on in PopART with NGO testing residents and bussing them out if living with HIV created mistrust of PopART.</p>

*Bond, V., Hoddinott, G., Viljoen, L., Ngwenya, F., Simuyaba, M., Chiti, B., Ndubani, R., Makola, N., Donnell, D., Schaap, A. and Floyd, S., 2021. How ‘place’ matters for addressing the HIV epidemic: evidence from the HPTN 071 (PopART) cluster-randomised controlled trial in Zambia and South Africa. *Trials*, 22, pp.1-13.

Supplementary file 2

The HPTN 071 (PopART) trial, the HPTN 071a stigma and P-ART-Y ancillary studies

The HPTN 071 (PopART) trial defined each community as the catchment area population of a public primary health facility delivering ART, and populations varied in size, from 18,000 to 100,000. The PopART trial aimed to reduce HIV incidence through a combination HIV prevention package that involved delivering HIV services to all households in intervention communities through a door-to-door approach (Hayes et al., 2014). There was no stigma reduction component in the PopART intervention driven by an assumption that ART and service access would reduce stigma. In this analysis, we draw on two social science components conducted in all 21 communities: a rapid qualitative assessment (referred to as the 'Broad Brush Survey' (BBS) approach) prior to the trial implementation (Bond et al., 2019a) and a mix of qualitative methods to assess the story of the trial implementation and community response (ibid). The HPTN 071a stigma ancillary study aimed to establish whether PopART reduced, increased, or had no effect on HIV stigma and drew on qualitative community data and parallel quantitative stigma measures from three population groups: community members self-reported to be living with HIV, community members self-reported to not be living with HIV and health workers self-reported as not living with HIV (Hargreaves et al., 2016, 2022). The P-ART-Y ancillary study boosted the PopART intervention reach for young people from 2016-18, using qualitative data to inform the design of an intervention with young people and quantitative data to evaluate the intervention reach (Shanaube et al., 2020).

Supplementary file 3

For the quantitative stigma data, three populations were asked stigma questions following a parallel and longitudinal approach, thus the questions aimed to investigate different perspectives about the same phenomenon in each of the populations over time (Hargreaves et al., 2016). Two of the populations were from the Population Cohort (PC) in the main PopART trial; namely community members who were not living with HIV and community members who were living with HIV. Participants from the PC were selected randomly at each round. The third population was an open cohort of self-reported HIV negative health workers recruited as part of the nested stigma ancillary study, which on an annual basis, approached all health staff in 21 government health facilities to ask them to respond to a stigma survey. The two populations from the PC were interviewed at 4 different timepoints over a period of six years, these time points are denoted as PC0, PC12, PC24 and PC36 on the accompanying graphs. The health worker cohort was interviewed three times over four years, denoted by round 1 (R1), round 2 (R2), and round 3 (R3).

Among participants living with HIV, we reported on three stigma domains made from a total of 11 stigma items. The first domain reported was current internalised stigma and it was comprised of three items, the second was stigma experienced in community comprised of five items, the third domain was healthcare settings stigma made of three items. These domains were combined into one indicator to reflect any stigma reported by the cohort of participants living with HIV. The cohort of HIV negative participants responded to 11 items capturing four stigma domains. The first domain explored hesitation to test for HIV due to fear of other people's reaction if the test was positive and it was comprised of one item. The second domain explored fear and judgement of people living with HIV (PLHIV,) and it was comprised of three items, the third, perceived stigma in community contained five items and the last domain focused on perceptions of stigma in the healthcare settings was formed from two items. The cohort of health worker (HW) participants responded to 14 items capturing three stigma domains the first being fear and judgement of PLHIV which was comprised of five items, the second perceived stigma in the community was also comprised of five items and the last domain was perceived co-worker stigma made up of four items. All individual stigma items were either pre-coded using a 4-item Likert scale ("Strongly agree" (3), "agree" (2), "disagree" (1), "strongly disagree" (0)) or categories relating to frequency of experiences (never, once, a few times, often) in the last year. During analysis all the outcomes were collapsed into binary variables (i.e., agree vs disagree and 'never' vs 'at least once').

Supplementary file 4

Zambia: ZACom01 (Arm A)

The HIV prevalence in ZACom01 at the time of the study in 2013-14, was 17.4%, and in 2018, HIV incidence was 1.6% (Bond et al., 2021). Lying along a railway line and close to a district town centre, ZACom01 was very clearly demarcated into two contrasting areas on either side of a main road. There was a planned area with older, concrete houses with small yards and gravel roads and some larger, private houses and an unplanned densely populated area with small clay houses and bad roads and a stream (prone to flooding). In 2013, the population of 53,392 was mainly comprised of a lower socio-economic class residing in the unplanned area. Participants described social bonding as strong amongst this group. However, residents also described that this group was often blamed by some of the older and new middle class in the planned area for disease, misfortune, crime, and low literacy. Historically, ZACom01 could be an unsafe place although crime was said to reduce during the period of PopART. Against this background of strong class divisions and inequity, mistrust of “others” was heightened, and participants often noted how this manifested in Satanism fears, blaming others and rumour mongering.

Local services include a government health facility, two government primary schools, many community schools, a few private schools, a police post, a local court, a medical store for the Ministry of Health, two big busy markets and one small market, two guest houses, an abattoir, three football pitches, some NGO offices, many churches, and some renowned traditional healers. There is a long history of HIV initiatives in ZACom01, dating back to home-based care initiatives in the early 1990s. In 2016, there were 16 HIV stakeholders with broad based activities. Close to the boundaries of ZACom01, there were many other options

for HIV testing and accessing ART. Residents also noted that although Pentecostal faith healing and pastors were reputed to “heal” HIV, openness to discuss ART and trust in ART were widespread. The PopART study met with some community resistance and challenges reaching mobile residents and middle-class residents but, according to participants, the study intervention became more acceptable over time, although it was sometimes confused with other stakeholder initiatives.

In ZACom01, dominant livelihoods were trading and/or vegetable farming, buying and/or selling in the town centre or local markets. A minority of residents had formal employment in government, factories, mines, security firms, domestic work, construction, shopping malls and hotels. Many residents, including secondary school children, headed off into town daily. Brewing and selling alcohol were common. Some participants noted that transactional sex and sex work were identified as livelihood options for local women. Many residents felt that ‘outsiders’ came into the community to drink, gamble, and watch video shows, sometimes striking up sexual relationships with local women or accessing sexual services. There was, in 2016, a sense of empowerment, enterprise and openness amongst young people as well as frustration with educational and work opportunities.

South Africa: SACom04 (Arm A)

The HIV prevalence in SACOM04 in 2013-14 was 10.8% and HIV incidence in 2018 was 0.6%, amongst the lowest of all South African trial communities (Bond et al., 2021). SACom04 consisted of several small but rapidly expanding communities in the semi-urban Cape Winelands of South Africa with an estimated population of ~15000 residents in 2013. Local services included several schools, shops (formal and informal), churches, a library, sports

facilities, and one public health facility, although other health facilities, including a day hospital, are nearby.

Residents were mostly employed as seasonal farm workers, in nearby factories, in tourism, or as domestic workers or gardeners. However, high levels of unemployment persisted.

Community members described how residents in the lower SES also resorted to "scavenging" or going through trash to find food. There were also reports of gang member involvement in crime and drug dealing to generate income. Transport (taxis) were available and community members were very mobile (daily and seasonal).

According to residents, there was a small enclave with older, formal housing close to the government health facility houses where the residents from one racial/language group in the community lived. This group had some networks extending beyond the boundaries of the place. These residents were comparatively more affluent with higher SES than residents in the newer, informal neighbourhoods where many residents were unemployed. Residents in these newer areas were predominantly identified as belonging to another racial group speaking another language, with strong ties to another province. There were also a few migrants from elsewhere in the African continent. Community groups noted that there were strong social divisions and segregation between these groups.

Rapid changes, along with high levels of unemployment, crime, alcohol use, and gangsterism meant that the community presented as unstable and chaotic (Bond et al., 2021). The community was closed and resistant to intervention and there was a general suspicion of outsiders. Participants described how there were also visible tensions in the community – between neighbours, and social groups - and distrust of public health services. Others noted how church/religion, family, and patriarchy were strong influences that provide some

cohesion and a closed community feel for many coloured residents. There was a strong link to traditional values and alternative treatment options (herbs, religion). However, according to residents, high levels of crime, intimate partner violence, drug use, gangsterism, and teenage pregnancy persisted.

There was some resistance to the people working at the local clinic and the participants described the facility as unpopular. However, for many this was the only near-by health care option and there were limited NGO HIV initiatives. There was initially some resistance to the PopART study-employed health workers.

Zambia: ZACom02 (Arm C)

The HIV prevalence in 2013-14 in ZACom02 was 28.1% and HIV incidence in 2018 was 2.4%, the highest of all Zambian communities in the trial (Bond et al., 2021). In 2013, ZACom02 had a population of 35, 146 (17,573 >18). An urban community with a rural tail, ZACom02 lies a few kilometres from a town centre. Local services included a government health facility, three government schools (including a secondary school), some private schools, many churches, a police post, some NGO offices, a community hall and two markets.

Many residents moved on a daily basis to the town centre and back to trade or look for work in construction and other industries. Some residents were small farmers, and a few were formally employed. Most residents described their livelihood pursuits as precarious and informal and income opportunities for young people were limited. Community members also described how alcohol sold in bars and household yards were perceived as pulling outsiders into the community. Young women going into town nightclubs were labelled by some participants as “prostitutes”.

The community rapidly changed during the PopART trial because the town became a new provincial capital in 2012. Historically, ZACom02 was ethnically homogenous and mostly poor, with conservative leadership rooted in the church, a political opposition party, established residents and village hierarchy. It had a reputation of being a helping community although, according to participants, residents had a tendency to be suspicious of new initiatives and outsiders. With an influx of civil servants from 2012 onwards, looking for housing, schooling and to establish social networks, residents described how ZACom02 became a more congested, diverse and chaotic place. Initially, civil servants looked for housing to rent, driving rental costs up, returning to their families over the weekends and/or holidays. This working away from home arrangement was described by participants as facilitating sexual relationships between civil servants and local residents. Over time many civil servants purchased undeveloped land from the council and started building their own houses so they could settle with their families. Thus, social networks became more extensive, social boundaries more flexible and open to outsiders and more money was in circulation.

Other than the local health facility, the only other option for accessing ART was from the local district hospital. Participants described how, at times, people living with HIV would turn to faith healing and traditional healing. Dating back to the late 1980s, there was a long history of HIV initiatives in ZACom02, including a national counselling and testing NGO, home based care, and church activities, dating back to the late 1980s. In 2015, other than the health facility and PopART, there were nine active HIV stakeholders, including the Network of Zambian People living with HIV (NZP+). Target populations were mainly leadership, PLWH, orphans and vulnerable children, sex workers and youth (in and out of school).

South Africa: SACom03 (Arm C)

SACom03 had an exceptionally high HIV prevalence of 35,7% and the highest incidence of the South African sites (2,3%). With approximately 12000 residents, it was established approximately 15 years ago on the northern outskirts of the city of Cape Town as an overspill area for people looking for work in the city. It is located between extended agricultural properties and the national highway. Most infrastructure was new, including the small government health facility, the community hall, and the local market. NGO activity in the area was limited, and only one NGO provided care for young PLHIV.

After a period of rapid change as the community was being established, the place felt more stable, and few changes occurred during the trial period. There were several schools for the mostly young community. Housing in the area was medium-high density and government subsidised with small pockets of informal housing with limited resources. The community was mixed, with mostly Xhosa speaking residents, a few Afrikaans speaking residents, and some migrants from other African countries.

There were high levels of unemployment with limited employment opportunities outside of the community. Residents were employed mostly in the informal market (gardeners, cleaners). However, there was some evidence of entrepreneurship as some residents sold goods and there were community initiatives including gardening and sewing clubs.

According to residents, there were limited networks due to the newness of the community. Participants described SACom03 as open as it lacked cohesiveness, but also closed in that there was resistance to interventions. Many community members described how there was no shared identity and there was a noted lack of leadership. Some resident mentioned incidents of xenophobia towards other Africans and SACom03 was described as a place

where people were suspicious and cautious. There was the expectation from participants that the lack of social cohesion meant that community members had very little social capital against negative events. During qualitative interviews, community members and community health workers reported low levels of HIV-status disclosure to intimate partners and extended family members.

The local public clinic had a limited number of staff and serious cases and after-hours care referred to a day hospital ~5km from the clinic.