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The social network context of HIV stigma: population-based, sociocentric network study in rural Uganda

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Abstract

Rationale: HIV-related stigma profoundly affects the physical and social wellbeing of people living with HIV, as well as the community's engagement with testing, treatment, and prevention. Based on theories of stigma elaborating how it arises from the relationships between the stigmatized and the stigmatizer as well as within the general community, we hypothesized that social networks can shape HIV-related stigma.

Objective: To estimate social network correlates of HIV-related stigma.

Methods: During 2011-2012, we collected complete social network data from a community of 1669 adults ("egos") in Mbarara, Uganda using six culturally-adapted name generators to elicit different types of social ties ("alters"). We measured HIV-related stigma using the 9-item AIDS-Related Stigma Scale. HIV serostatus was based on self-report. We fitted linear regression models that account for network autocorrelation to estimate the association between egos' HIV-related stigma, alters' HIV-related stigma and alters' self-reported HIV serostatus, while adjusting for

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egos' HIV serostatus, network centrality, village size, perceived HIV prevalence, and sociodemographic characteristics.

Results: The average AIDS-Related Stigma Score was 0.79 (Standard Deviation=0.50). In the population 116 (7%) egos reported being HIV-positive, and 757 (46%) reported an HIV-positive alter. In the multivariable model, we found that egos' own HIV-related stigma was positively correlated with their alters' average stigma score (b=0.53; 95% confidence interval [CI] 0.42-0.63) and negatively correlated with having one or more HIV-positive alters (b=-0.05; 95% CI -0.10 to -0.003).

Conclusion: Stigma-reduction interventions should be targeted not only at the level of the individual but also at the level of the network. Directed and meaningful contact with people living with HIV may also reduce HIV-related stigma.

1. Introduction:

HIV-related stigma profoundly affects people living with HIV (PLH) as well as the general community. Stigma is an "attribute that is deeply discrediting" that reduces the person "from a whole and usual person to a tainted, discounted one" (p. 3) (Goffman, 1963). Stigma arises from the differential access to social, economic, and political power between the stigmatizer and the stigmatized, and perpetuates social hierarchies by reducing the status of the stigmatized (Gilmore & Somerville, 1994; Link & Phelan, 2001). Power relations are central to how the stigma process unfolds. The manner in which stigma is deployed is historically contingent and varies from setting to setting, and stigma is often layered over pre-existing societal fault lines including those related to gender, race, and class (Gilmore & Somerville, 1994). Stigma manifests in different, overlapping ways: the internalization of negative attitudes and stereotypes by stigmatized individuals (internalized stigma); expectations of rejection by the community were one's stigmatized status to become known (anticipated stigma); and acts of discrimination or hostility towards stigmatized individuals (enacted stigma) (Scambler & Hopkins, 1986; Steward et al., 2008; B. Turan et al., 2017b). When experienced or internalized by PLH, HIV-related stigma affects their personal and social wellbeing as well as their outcomes in the HIV care continuum. Among PLH, HIV-related stigma has been linked to depression (Simbayi et al., 2007; Tsai et al., 2012) and increased HIV transmission risk behavior (Burnham et al., 2016; Siedner et al., 2014), prevents them from disclosing their status to their friends and family (Bogart et al., 2008; Tsai et al., 2013a) and compromises their ability to obtain social support (Takada et al., 2014). HIV-related stigma further leads to poor engagement with care (Vanable et al., 2006) and poor adherence to treatment (Katz et al., 2013; Li et al., 2014). Stigma more generally also affects access to resources that are in turn associated with improved health outcomes, including employment opportunities, housing, and access to medical care (Link & Phelan, 2006).

Among people in the general population, HIV-related stigma has been associated with delays in HIV testing (Genberg et al., 2009; Kelly et al., 2016), HIV transmission risk behavior (Delavande et al., 2014; Kelly et al., 2017), and negative spillover effects on other health behaviors of interest, including maternal and child health (Ng & Tsai, 2017; Turan et al., 2011; Turan et al., 2012; Turan et al., 2008). Stigma has been implicated in delays in response to the global HIV epidemic (Castro & Farmer, 2005), as people continue to present

for HIV care and initiate antiretroviral therapy at advanced stages of disease (Siedner et al., 2015). Therefore, reduction or elimination of HIV-related stigma is a critical component of the global response to the HIV epidemic (Turan et al., 2017b; Turan & Nyblade, 2013). However, much remains to be done to develop interventions that effectively eliminate stigma, particularly at the interpersonal and community levels (Stangl et al., 2013).

This study aimed to refine our understanding of the interpersonal aspects of HIV-related stigma through the study of a whole-population social network in rural Uganda. We addressed two fundamental questions about the process of stigma: (1) How do the stigmatizing beliefs of social ties shape one's own stigmatizing beliefs? (2) How does having HIV-positive social ties affect one's own stigmatizing beliefs?

2. Conceptual Model:

The classic enjoinder of Goffman (1963) was that stigma needs to be discussed in the "language of relationships, not attributes" (p. 3). Stigma is socially constructed: it is specific to the social context in which the stigmatized and the stigmatizer relate to each other, and to the larger context of the community (Farmer, 2006; Major & O'Brien, 2005). Yet few studies have elaborated how social ties help create and shape stigmatizing beliefs.

We hypothesize that social networks can potentially shape HIV-related stigma in two ways. First, peers can shape HIV-related stigma, just as peers shape and spread diverse health-related norms and behaviors (Christakis & Fowler, 2007, 2008; DiMaggio & Garip, 2012; Kuhns et al., 2017; Schneider et al., 2013; Tankard & Paluck, 2016). In resource-limited settings compared with resource-rich settings, social networks may play a more powerful role in the dissemination of information and norms (Perkins et al., 2015). Social networks have been shown to influence latrine use (Shakya et al., 2014) and polio vaccine uptake (Onnela et al., 2016) in India, normative beliefs about intimate partner violence in rural Honduras (Shakya et al., 2016), creation of sanitation infrastructure in rural Ecuador (Zelner et al., 2012), normative beliefs and behaviors regarding HIV transmission behaviors among young Tanzanian men (Mulawa et al., 2016b), and HIV testing behavior (Mulawa et al., 2016a; Perkins et al., 2018).

Second, PLH might be able to positively influence stigmatizing beliefs among their social ties. Allport (1954) theorized that meaningful communication and collaboration, under appropriate conditions, between members of a majority group and a minority group could lead to decreased prejudice towards the minority group. Empirical studies have since shown that such interactions improve people's attitudes toward stigmatized populations (Broockman & Kalla, 2016; Desforges et al., 1991; Phelan & Link, 2004). Related to this body of work, studies have shown that people living in areas of higher HIV prevalence (Genberg et al., 2009), or those who have personal contact with PLH (Chan & Tsai, 2017), are less likely to endorse negative attitudes toward PLH. One mechanism through which personal contact is expected to operate is the induction of empathy (C. D. Batson et al., 1997), the ability to recognize and understand another's perceptions and feelings. Prior work has shown that the induction of empathy for a member of a stigmatized group has led to

improvements in attitudes toward the group as a whole (C. Daniel Batson et al., 2002; C. D. Batson et al., 1997).

3. Method

3.1 Ethics statement.

All respondents provided written informed consent, either with a signature or with a thumbprint if unable to write. All study procedures were approved by the Committee on the Use of Human Subjects in Research, Harvard University and the Institutional Review Committee, Mbarara University of Science and Technology. Consistent with national guidelines, we also received clearance from the Uganda National Council for Science and Technology and the Research Secretariat in the Office of the President. The institutional review board of the University of California, Los Angeles confirmed that the secondary data analysis described in this manuscript was exempted from review. Study setting and population

The study was conducted between 2011 and 2012 in Mbarara, a rural region of southwestern Uganda. The local economy is driven primarily by subsistence agriculture, animal husbandry, and small-scale trading; food and water insecurity are fairly common (Perkins et al., 2018; Tsai et al., 2011; Tsai et al., 2016). At the time of the study, the HIV prevalence in the southwestern region of Uganda was 8% (Ministry of Health/Uganda & ICF International, 2012). Nyakabare Parish, composed of 8 villages, was chosen among several candidate study sites because of its history of low migration, long period of settlement, and clear governmental and geographic boundaries. We collected data from all adults aged 18 years and older. People who did not report stable residence in the parish, and people who could not communicate meaningfully with research staff (e.g., due to acute intoxication or cognitive impairment), were excluded. There were a total of 1747 eligible respondents, 1669 (95.5%) of whom were interviewed.

3.2 Data collection.

Interview materials were translated from English into Runyankore by trained research assistants, back-translated to ensure fidelity to the original text, and pilot-tested to ensure cultural sensitivity and appropriateness to the local context. Data were collected in two stages. During the first stage, the research team went from household to household to conduct a census of all eligible adults. They collected demographic information and obtained photographs of each eligible respondent. During the second stage, the research team administered confidential, one-on-one, paper-based survey interviews, eliciting each respondent’s social networks and using photographs as visual aids to confirm identities. Surveys were also used to elicit self-reported HIV serostatus and other variables of interest, including HIV-related stigma.

3.3 Primary variables of interest.

To elicit ties, we administered 6 different name generators. These name generators were modeled after classic name generators such as those used in the General Social Survey (Burt, 1984; Marsden, 1990) and adapted for the local context through focus group studies

with key informants. We used multiple, role- and behaviorally-specific name generators because we sought to elicit the full range of ties between respondents, and single name generators often do not suffice (Bearman & Parigi, 2004; Shakya et al., 2017). Respondents were asked to name people with whom they had particular kinds of interactions in the past 12 months: (1) people with whom they spend leisure time; (2) people with whom they discuss financial matters; (3) people with whom they discuss health matters; (4) people who provide emotional support; (5) people with whom they exchange food; and (6) kin/relatives. (The Supplementary Appendix online provides the full text of the name generators in their entirety.) For each name generator, except for that eliciting kin networks, the index respondent (subsequently referred to as the “ego”) was permitted to identify up to six adults (subsequently referred to as “alters”) residing within the parish.

Using these data, we generated a network graph of the parish. In contrast to egocentric network studies that elicit egos’ alters and egos’ perceptions of the ties between alters (Granovetter, 1973), sociocentric network studies capture ties between all individuals within the community (Moreno, 1953). Sociocentric studies therefore do not rely on egos' perceptions of their alters' beliefs, behaviors, and relationships because the alters are also respondents, and these types of studies can more accurately characterize egos' embeddedness within the network because the embeddedness of the egos' alters is also known (Perkins et al., 2015). For example, in our study, we elicited HIV-related stigma and HIV serostatus directly from respondents (egos and alters) rather than rely on egos’ potentially inaccurate perceptions of their alters’ beliefs and HIV serostatus (Almaatouq et al., 2016; Butts, 2003; Kumbasar et al., 1994; Mulawa et al., 2016a). Many network studies related to health and health behaviors have measured a person’s immediate social network, but in resource-limited settings, sociocentric studies are rarely done (Helleringer et al., 2009; Perkins et al., 2015; Schneider et al., 2015).

The outcome of interest was HIV-related stigma, which we measured using the 9-item AIDS-Related Stigma Scale (Kalichman et al., 2005). The scale was administered to all respondents regardless of their self-reported HIV status. The scale consists of 9 statements worded as negative attitudes toward PLH and elicits respondents’ endorsement of each item on 4-point Likert-type scale ranging from “strongly disagree” to “strongly agree.” Each item is scored from 0 to 3. Egos’ total scores were calculated as the average of the 9 items, and we also calculated the mean stigma scale scores of each ego’s alters. We reverse coded one item so that a higher number on the total score corresponds to more stigmatizing attitudes towards PLH. The scale showed acceptable internal consistency (α=0.78).

We collected self-reported data on each respondent’s self-reported HIV status (HIV positive, HIV negative, or unknown). For each ego, we then used the network data to determine whether he or she had any alters who reported being HIV positive. We did not confirm self-reported HIV serostatus with HIV testing. It is rare for people to report being HIV positive when they are actually seronegative (Macro International and National Statistical Office, 2011). On the other hand, it is possible that some people reported being HIV negative when they were in fact HIV positive. However, our estimate of self-reported HIV prevalence (7%) closely matched the HIV prevalence estimate for the southwestern Uganda region (8%) in the 2011 Uganda AIDS Indicator Survey that was based on unlinked anonymous HIV testing

(Ministry of Health/Uganda & ICF International, 2012); therefore we anticipate that any potential bias resulting from misclassification would be minimal.

3.4 Other explanatory variables.

We asked respondents what they perceived to be the prevalence of HIV in the community, because prior literature has shown that HIV prevalence is associated with lower levels of stigma (Genberg et al., 2009). The wording of the survey question was as follows: "If there were 100 people in your village, how many of them do you think would actually have HIV/AIDS?" Due to clumping in the data, the perceived HIV prevalence variable was dichotomized at >50% ("high") vs. 50% or less ("low").

Based on the theory that stigmatization is contingent on differential access to social, political, or economic power between the stigmatizer and the stigmatized (Link & Phelan, 2001), we included in the regression models covariates that represent different forms of power in the community – namely, social embeddedness and socioeconomic status. To measure social embeddedness for each ego, we calculated his or her eigenvector centrality, which is a form of degree centrality that differentially weights each alter by the embeddedness of that alter (Bonacich, 1972, 1987). Egos whose alters are better connected have higher eigenvector centrality compared to egos whose alters are less connected. We also included in the regression models two traditional measures of socioeconomic status: educational attainment and household wealth. Educational attainment was dichotomized at primary school completion vs less than primary school completion. Household wealth was measured using an asset index based on 26 different household items and housing characteristics (Filmer & Pritchett, 2001).

Other sociodemographic variables collected were age, religion, sex, and marital/partnership status, all of which have been shown prior literature to be associated with HIV-related (Mugoya & Ernst, 2014; Nabukenya & Matovu, 2018; Treves-Kagan et al., 2017; Youssef et al., 2018). We categorized religion into the two most common religions, Protestant or Catholic, and a third category of all other responses. We categorized marital status into single, married, and divorced/separated.

3.5 Statistical analysis.

We sought to understand how egos' HIV-related stigma was associated with the HIV serostatus and HIV-related stigma of their alters. We conducted bivariate analyses to estimate the association between HIV-related stigma and the variables described above. We then specified a nested taxonomy of linear regression models in which the ego's stigma scale score was specified as a function of the ego's own HIV serostatus and the ego's perception of HIV prevalence, the presence of an HIV-positive alter within the ego's network, and the mean HIV-related stigma score among the ego's alters. In the multivariable regression models, we also adjusted for the ego's age, sex, marital status, religion, educational attainment, population of the ego's village, and network centrality. The packages *Igraph* version 2.0 and *sna* version 2.4 were used to conduct social network analyses in R (version 3.4.1). We graphed the network using the Kamada-Kawai algorithm.

Because egos and alters may share unmeasured influences that affect their joint distribution of HIV-related stigma, a simple linear regression model could potentially overestimate the association between egos' own stigmatizing beliefs and the stigmatizing beliefs of their alters. Therefore, we specified an autoregressive model using the linear network autocorrelation model (*lnam*) function in the *sna* package that allowed us to simultaneously model both individual- and network-level effects by taking into account the correlations between the residuals of egos and alters (Leenders, 2002; O'Malley & Marsden, 2008).

The extent of missing data differed by variable: 88 respondents were missing one or more responses for the HIV-related stigma scale, while only 15 were missing age. Eighty-four (5.4%) people without HIV were missing the stigma scale, while 4 (3.4%) people with HIV were missing the stigma scale ($\chi^2 = 0.50$, $p = 0.48$). We used standard multiple imputation in R to create 10 multiply imputed datasets. Multiple imputation proceeded under the assumption of missingness at random, allowing missingness to depend on observed variables and to take full advantage of all observed correlations when generating imputations. The resulting datasets contained 1648 observations, and the remaining 21 observations missing social network information were not included in the regression analyses. The unadjusted bivariate analyses and the nested taxonomy of regression analyses were conducted with each of the imputed datasets, and the parameter estimates and standard errors were adjusted for variability among imputations based on Rubin's combination rules (Little & Rubin, 2002).

We conducted two types of sensitivity analyses. First, we evaluated the robustness of the association between exposure and outcome using the *E*-value, defined as the minimum strength of association that an unmeasured confounder would need to have with both the exposure and outcome, conditional on the measured covariates, to explain away any observed exposure-outcome association. We calculated the *E*-value using an approximated risk ratio based on the standardized effect size ($RR \approx \exp(0.91 \times d)$, as recommended by VanderWeele and Ding (2017). Second, we fitted the final model using the average stigma score only of alters who did not report being HIV positive (i.e., they reported being HIV-negative or did not know their serostatus), to account for the possibility that HIV-positive alters may have lower levels of HIV-related stigma compared with HIV-negative alters or alters of unknown serostatus.

4. Results

4.1 Descriptive statistics.

We interviewed 1669 of 1747 (95.5%) eligible respondents. The mean age of respondents was 37 years (standard deviation [SD] 18.1), and most respondents were women (926 [54%]), married (939 [58%]), Protestant (1135 [69%]), and did not complete primary school (1127 [69%]) (Table 1). Seven percent (113) of respondents reported being HIV-positive. More than a quarter (497 [30%]) of the respondents believed that the HIV prevalence of the community was greater than 50%. The average AIDS-Related Stigma Score was 0.79 (SD 0.50). Most respondents (97%) had stigma scores less than 2.

In response to the name generators, respondents nominated an average of 5.35 ($SD = 2.99$, range 0 - 19) non-overlapping alters (outdegree). When including both alters nominated by

the ego and alters who nominated the ego (total degree), the mean number of alters was 9.77 (*SD* = 5.52, range 0 - 55). The mean outdegree and total degree are comparable to those reported in social network studies conducted in a variety of settings worldwide (Chami et al., 2017; Marsden, 1987; Shakya et al., 2017; Yamanis et al., 2016). Almost half (757 [45%]) of the egos had at least one alter who reported being HIV positive. In total, 1870 people were included in the social network of the community, with the network graph shown in Figure 1.

4.2 Correlates of HIV-related stigma.

In bivariate analyses (Table 2, first column), egos' HIV-related stigma scale scores were significantly correlated with the average stigma scores of their alters (*b* = 1.03 per point on the stigma scale; 95% confidence interval [CI] 1.01 to 1.04, $p < 0.001$). In addition, self-reported HIV seropositivity (*b* = 0.14; 95% CI 0.014 to 0.27, $p = 0.03$) and thinking that HIV is highly prevalent in the community (b= 0.34; 95% *CI* = 0.04 to 0.30, $p<0.001$) were associated with higher levels of HIV-related stigma.

Columns 2 and 3 of Table 2 show a nested taxonomy of multivariable linear regression models. Model 1 includes the ego's individual characteristics. Model 2 includes additional individual characteristics (HIV serostatus, perception of HIV prevalence in the community, village size) and network characteristics (eigenvector centrality, whether he or she has alters with HIV, and the average stigma score of the ego's alters). In this model, we found that egos' HIV-related stigma scale scores were significantly correlated with the average stigma score of their alters (*b* = 0.53 per point on the stigma scale; 95% *CI* 0.42 to 0.63, $p < 0.001$). In terms of the magnitude of this estimate, the estimated regression coefficient was slightly larger than the sample standard deviation (0.53/0.50=1.05). In relative terms, the estimated regression coefficient was approximately two-thirds of the sample mean (0.53/0.79=0.67). Both of these calculations imply an estimate that is substantively and statistically significant.

Of note, egos with an HIV-positive alter had higher HIV-related stigma scores on bivariate analysis (*b* = 0.26; 95% *CI* = 0.016 to 0.314, $p< 0.001$) but lower HIV-related stigma scores in the final multivariable regression model (*b* =−0.053; 95% *CI* = −0.104 to −0.003, $p=0.040$). This result was largely driven by the inclusion of two covariates in the multivariable regression model: age and alters' average stigma score. When either covariate was added to the bivariate model, the positive association between egos' HIV-related stigma scores and having an HIV-positive alter flipped and became negative.

Sensitivity analysis for unmeasured confounding showed that only an unmeasured confounder that was strongly associated with the egos' and their alters' average stigma scores, above and beyond the measured covariates included in the regression models, could explain away the estimated association. Using the conversion formula provided by VanderWeele and Ding (2017), we obtained an approximate relative risk of 2.61 (95% *CI* = 2.16 to 3.15) and an *E*-value of 4.66. Thus, strong confounding from an unmeasured confounder would be required to explain away the estimated association. The *E*-value analysis showed a less robust association between egos' stigma scores and having an alter with HIV, with an approximate *E*-value of 1.44.

Sensitivity analysis for the final model conducted using the average stigma score of alters without HIV showed estimated coefficients that were similar in terms of magnitude and direction (Supplementary Table).

5. Discussion

In this population-based, sociocentric social network study from rural Uganda, we found important evidence of peer associations in HIV-related stigma. We found that an ego's HIV-related stigma score was higher if his or her alters' stigma scores were higher, and an ego's HIV-related stigma score was lower if he or she had one or more alters with HIV. The estimated associations were statistically significant, robust to the inclusion of multiple covariates including HIV serostatus and perceived HIV prevalence, and were also robust to adjustment for unmeasured network confounders with the autocorrelation model.

Consistent with our hypothesis, an ego’s HIV-related stigma score was positively correlated with the average stigma score of his or her alters (see Table 2). Similar findings in the clustering of health-related attitudes among social network peers have been found in studies of other health behaviors, including polio vaccine hesitancy (Onnela et al., 2016), latrine ownership (Shakya et al., 2015) and HIV risk and preventive behaviors (Kuhns et al., 2017; Mulawa et al., 2016a; Mulawa et al., 2016b; Perkins et al., 2018). Several mechanisms could link social ties to HIV-related stigma. First, alters can directly influence an ego’s attitudes toward PLH. Second, alters can indirectly shape an ego’s attitudes toward PLH by shaping his or her underlying knowledge about HIV (Kalichman et al., 2005), including perceived access to HIV treatment (Castro & Farmer, 2005; Chan & Tsai, 2016; Chan et al., 2015; Perkins et al., 2018; Wolfe et al., 2008) and HIV prevalence (Genberg et al., 2009), both of which have been associated with lower levels of HIV-related stigma. Third, alters can shape cultural beliefs that create hierarchies of physical or behavioral characteristics that are considered desirable or undesirable (Link & Phelan, 2001). Fourth, alters can also shape the norms of reciprocity in the community; when a person is unable to engage in the norms of reciprocity, they become targets of stigma (Neuberg et al., 2000). For example, when a person with mental illness violates norms of social exchange, he or she generates feelings of danger, uncertainty, and defensiveness in others, and thereby loses moral standing in the community (L. H. Yang & Kleinman, 2008). Similarly, when PLH are perceived to lack the ability to participate in reciprocal economic exchange because of HIV-associated illness, this circumstance can lead to stigmatization of PLH in resource-limited settings (Tsai et al., 2013b).

We also found that an ego who has one or more HIV-positive alters reported lower levels of HIV-related stigma (see Table 2), providing evidence potentially consistent with the contact hypothesis (Allport, 1954). Prior literature has shown that people who live in higher-prevalence communities tend to have less stigmatizing attitudes toward PLH (Genberg et al., 2009). Subsequent studies have shown that personal contact with PLH is negatively correlated with stigmatizing attitudes toward PLH, and that the inverse association is stronger when the PLH is a family member or a friend (Chan & Tsai, 2017; Mall et al., 2013). Our regression models adjusted for perceived HIV prevalence, and showed that being connected to a PLH, rather than the belief that having HIV is normative in the community, is

associated with less stigma. This finding is consistent with Allport's original theory that superficial contact does not decrease negative attitudes, and that stigma reduction requires contact between people of equal status in pursuit of common interests (Allport, 1954). The finding is particularly notable because thirty percent of the respondents stated that they believed more than half of their community was HIV positive -- an order of magnitude higher than the actual prevalence of HIV in the community.

Consistent with the theory that stigmatization requires differential access to power (Link & Phelan, 2001), eigenvector centrality, a measure of how well-connected an ego is to other well-connected alters, was positively correlated with stigma (see Table 2). However, educational attainment was negatively correlated with stigma. In prior studies, the association between educational attainment and stigma has been mixed, (Chiao et al., 2009; Stuber et al., 2009; Tsai & Venkataramani, 2015; Wolfe et al., 2008), while knowledge specifically about the disease condition has been associated with lower levels of stigma (Bogart et al., 2008; Girma et al., 2014; Mugoya & Ernst, 2014; H. Yang et al., 2006; Youssef et al., 2018). We further found that those who identified with Protestant or Catholic faith had higher levels of HIV-related stigma compared to those who identified as neither. While prior studies have shown association between Judeo-Christian religious beliefs and higher levels of HIV-related stigma primarily through the stigmatization of behaviors associated with HIV transmission (Bluthenthal et al., 2012; Diaz & Ayala, 1999; K. Quinn & Dickson-Gomez, 2016; Katherine Quinn et al., 2018; Varas-Diaz et al., 2010; Zou et al., 2009), they also show that religious beliefs and organizations serve as sources of support for PLH (Katherine Quinn et al., 2018), and provide motivation to care for them (Bluthenthal et al., 2012; Varas-Diaz et al., 2010).

The respondent's self-reported HIV serostatus was positively correlated with stigma in bivariate analyses (but the association did not persist as statistically significant after the inclusion of demographic and network variables). Research assistants were not blinded to respondents' self-reported HIV serostatus, but the two sections of the lengthy questionnaire were not placed adjacent to each other, so it is unlikely that research assistants' administration of these questions differed systematically for PLH compared with respondents who reported that their serostatus was unknown or HIV-negative. For PLH who endorsed any of the stigma items, their responses may reflect internalized stigma, which occurs when PLH accept their discredited status as valid and develop self-defacing internal representations of themselves along with guilt, shame, and other negative self-perceptions (Ashaba et al., 2018; M. Pantelic et al., 2015; Marija Pantelic et al., 2019; Steward et al., 2008; Tsai et al., 2013c; Bulent Turan et al., 2017a). Prior work has proceeded similarly in studying how PLH may or may not endorse negatively worded items like those contained in the AIDS-Related Stigma Scale, also interpreting such responses as potentially being consistent with internalized stigma (Tsai, 2015). This approach is also consistent with studies in which parallel scale items—nearly identical in scope but phrased differently—are administered to PLH vs. respondents in the general population in order to measure internalized stigma among PLH and negative attitudes toward PLH among people in the general population (Visser et al., 2008).

5.1 Limitations.

Interpretation of our findings is subject to limitations. First, the data are cross-sectional, which limits our ability to make causal inferences. While our network autocorrelation model (Leenders, 2002) attempts to account for exogenous, unmeasured influences that affect people who are connected to each other, our associational findings cannot distinguish between peer influence vs. homophily (McPherson et al., 2001). The e-value sensitivity analysis suggests that the observed association between egos' HIV-related stigma and stigma among their alters is robust to unobserved confounding. However, the observed association between egos' HIV-related stigma and having HIV-positive social ties was less robust; namely, it is possible that somewhat weaker confounding could explain away the observed association. Second, the data are all self-reported and therefore subject to the limitations inherent to all studies based on self-report data. Even though the study was conducted in a confidential manner, respondents may have chosen to hide their HIV serostatus due to fear of stigmatization, or hide their stigmatizing attitudes towards HIV due to social desirability (i.e., if they think others do not share this view), leading to underestimation of those variables. Third, while egos were instructed to name alters who resided within the parish, some egos named alters who resided outside of the parish, and this may have affected the calculated centralities for the egos. Finally, questions to elicit social ties can be interpreted differently by different respondents (Bearman & Parigi, 2004). However, we formulated name generators that were tailored for the local context and that were concretely phrased to reduce variability in interpretation (Brewer et al., 1999).

6. Conclusions

In this cross-sectional, population-based sociocentric social network study conducted in rural Uganda, we report two main findings. First, egos' HIV-related stigma was correlated with that of their alters. Second, an ego who had HIV-positive alters reported lower levels of HIV-related stigma, adjusting for perceived HIV prevalence. Our findings have important implications for policy makers. First, the clustering of negative attitudes towards HIV may suggest that changing attitudes toward HIV may require intervention not only at the level of the individual but also at the level of the network. Such an intervention may (for example) ask a person to recruit members of his or her social network peers to participate in an intervention together, or encourage peer-to-peer communication to create cascades in the diffusion of attitudes (Bouris et al., 2017; Morgan et al., 2018; Schneider et al., 2012; Valente, 2012). Second, our findings suggest that stigma reduction interventions should encourage community members to engage with PLH. Public health campaigns and policies that support judicious disclosure of HIV status, such as Uganda's couples HIV testing and counseling campaign (Knowledge for Health Project, 2012), might have benefits not only for PLH but also for peers, who may be influenced to develop more positive attitudes toward HIV.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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REFERENCES

Allport GW (1954). The nature of prejudice. Oxford, England: Addison-Wesley.

Almaatouq A, Radaelli L, Pentland A, & Shmueli E (2016). Are You Your Friends' Friend? Poor Perception of Friendship Ties Limits the Ability to Promote Behavioral Change. PloS one, 11, e0151588. [PubMed: 27002530]

Apicella CL, Marlowe FW, Fowler JH, & Christakis NA (2012). Social networks and cooperation in hunter-gatherers. Nature, 481, 497–501. [PubMed: 22281599]

Ashaba S, Cooper-Vince C, Maling S, Rukundo GZ, Akena D, & Tsai AC (2018). Internalized HIV stigma, bullying, major depressive disorder, and high-risk suicidality among HIV-positive adolescents in rural Uganda. Glob Ment Health (Camb), 5, e22. [PubMed: 29997894]

Batson CD, Chang J, Orr R, & Rowland J (2002). Empathy, Attitudes, and Action: Can Feeling for a Member of a Stigmatized Group Motivate One to Help the Group? Personality and Social Psychology Bulletin, 28, 1656–1666.

Batson CD, Polycarpou MP, Harmon-Jones E, Imhoff HJ, Mitchener EC, Bednar LL, et al. (1997). Empathy and attitudes: can feeling for a member of a stigmatized group improve feelings toward the group? Journal of Personality and Social Psychology, 72, 105–118. [PubMed: 9008376]

Bearman P, & Parigi P (2004). Cloning Headless Frogs and Other Important Matters: Conversation Topics and Network Structure*. Social Forces, 83, 535–557.

Bluthenthal RN, Palar K, Mendel P, Kanouse DE, Corbin DE, & Derose KP (2012). Attitudes and beliefs related to HIV/AIDS in urban religious congregations: barriers and opportunities for HIV-related interventions. Soc Sci Med, 74, 1520–1527. [PubMed: 22445157]

Bogart LM, Cowgill BO, Kennedy D, Ryan G, Murphy DA, Elijah J, et al. (2008). HIV-related stigma among people with HIV and their families: a qualitative analysis. AIDS and Behav, 12, 244–254.

Bonacich P (1972). Factoring and weighting approaches to status scores and clique identification. The Journal of Mathematical Sociology, 2, 113–120.

Bonacich P (1987). Power and Centrality: A Family of Measures. American Journal of Sociology, 92, 1170–1182.

Bouris A, Jaffe K, Eavou R, Liao C, Kuhns L, Voisin D, et al. (2017). Project nGage: Results of a Randomized Controlled Trial of a Dyadic Network Support Intervention to Retain Young Black Men Who Have Sex With Men in HIV Care. AIDS Behav, 21, 3618–3629. [PubMed: 29079949]

Brewer DD, Garrett SB, & Kulasingam S (1999). Forgetting as a cause of incomplete reporting of sexual and drug injection partners. Sex Transm Dis, 26, 166–176. [PubMed: 10100775]

Broockman D, & Kalla J (2016). Durably reducing transphobia: A field experiment on door-to-door canvassing. Science, 352, 220–224. [PubMed: 27124458]

Burnham KE, Cruess DG, Kalichman MO, Grebler T, Cherry C, & Kalichman SC (2016). Trauma symptoms, internalized stigma, social support, and sexual risk behavior among HIV-positive gay and bisexual MSM who have sought sex partners online. AIDS Care, 28, 347–353. [PubMed: 26461452]

Burt RS (1984). Network items and the general social survey. Social Networks, 6, 293–339.

Butts CT (2003). Network inference, error, and informant (in)accuracy: a Bayesian approach. Social Networks, 25, 103–140.

Castro A, & Farmer P (2005). Understanding and addressing AIDS-related stigma: from anthropological theory to clinical practice in Haiti. American Journal of Public Health, 95, 53–59. [PubMed: 15623859]

Chami GF, Kontoleon AA, Bulte E, Fenwick A, Kabatereine NB, Tukahebwa EM, et al. (2017). Diffusion of treatment in social networks and mass drug administration. Nature Communications, 8, 1929.

Chan BT, & Tsai AC (2016). HIV stigma trends in the general population during antiretroviral treatment expansion: analysis of 31 countries in sub-Saharan Africa, 2003–2013. Journal of Acquired Immune Deficiency Syndromes, 72, 558–564. [PubMed: 27035888]

Chan BT, & Tsai AC (2017). Personal contact with HIV-positive persons is associated with reduced HIV-related stigma: cross-sectional analysis of general population surveys from 26 countries in sub-Saharan Africa. J Int AIDS Soc, 20, 21395. [PubMed: 28362067]

Chan BT, Tsai AC, & Siedner MJ (2015). HIV Treatment Scale-Up and HIV-Related Stigma in Sub-Saharan Africa: A Longitudinal Cross-Country Analysis. American Journal of Public Health, 105, 1581–1587. [PubMed: 26066939]

Chiao C, Mishra V, & Sambisa W (2009). Individual- and community-level determinants of social acceptance of people living with HIV in Kenya: results from a national population-based survey. Health Place, 15, 712–720. [PubMed: 19179100]

Christakis NA, & Fowler JH (2007). The spread of obesity in a large social network over 32 years. New England Journal of Medicine, 357, 370–379. [PubMed: 17652652]

Christakis NA, & Fowler JH (2008). The collective dynamics of smoking in a large social network. New England Journal of Medicine, 358, 2249–2258. [PubMed: 18499567]

Delavande A, Sampaio M, & Sood N (2014). HIV-related social intolerance and risky sexual behavior in a high HIV prevalence environment. Social Science and Medicine, 111, 84–93. [PubMed: 24768779]

Desforges DM, Lord CG, Ramsey SL, Mason JA, Van Leeuwen MD, West SC, et al. (1991). Effects of structured cooperative contact on changing negative attitudes toward stigmatized social groups. Journal of Personality and Social Psychology, 60, 531–544. [PubMed: 2037965]

Diaz RM, & Ayala G (1999). Love, passion and rebellion: Ideologies of HIV risk among Latino gay men in the USA. Culture, Health & Sexuality, 1, 277–293.

DiMaggio P, & Garip F (2012). Network Effects and Social Inequality. Annual Review of Sociology, 38, 93–118.

Farmer P (2006). AIDS and accusation : Haiti and the geography of blame. Berkeley: University of California Press.

Filmer D, & Pritchett LH (2001). Estimating wealth effects without expenditure data--or tears: an application to educational enrollments in states of India. Demography, 38, 115–132. [PubMed: 11227840]

Genberg BL, Hlavka Z, Konda KA, Maman S, Chariyalertsak S, Chingono A, et al. (2009). A comparison of HIV/AIDS-related stigma in four countries: negative attitudes and perceived acts of discrimination towards people living with HIV/AIDS. Social Science and Medicine, 68, 2279–2287. [PubMed: 19427086]

Gilmore N, & Somerville MA (1994). Stigmatization, scapegoating and discrimination in sexually transmitted diseases: Overcoming ‘them’ and ‘us’. Social Science and Medicine, 39, 1339–1358. [PubMed: 7801170]

Girma E, Gebretsadik LA, Kaufman MR, Rimal RN, Morankar SN, & Limaye RJ (2014). Stigma against people with HIV/AIDS in rural Ethiopia, 2005 to 2011: signs and predictors of improvement. AIDS Behav, 18, 1046–1053. [PubMed: 24072513]

Goffman E (1963). Stigma; notes on the management of spoiled identity. Englewood Cliffs, N.J.,: Prentice-Hall.

Granovetter MS (1973). The Strength of Weak Ties. American Journal of Sociology, 78, 1360–1380.

Helleringer S, Kohler H-P, Chimbiri A, Chatonda P, & Mkandawire J (2009). The Likoma Network Study: Context, data collection, and initial results. Demographic research, 21, 427–468. [PubMed: 20179777]

Jackson MO (2008). Social and Economic Networks: Princeton University Press.

Kalichman SC, Simbayi LC, Jooste S, Toefy Y, Cain D, Cherry C, et al. (2005). Development of a brief scale to measure AIDS-related stigma in South Africa. AIDS Behav, 9, 135–143. [PubMed: 15933833]

Katz IT, Ryu AE, Onuegbu AG, Psaros C, Weiser SD, Bangsberg DR, et al. (2013). Impact of HIV-related stigma on treatment adherence: systematic review and meta-synthesis. J Int AIDS Soc, 16, 18640. [PubMed: 24242258]

Kelly JD, Reid MJ, Lahiff M, Tsai AC, & Weiser SD (2017). Community-Level HIV Stigma as a Driver for HIV Transmission Risk Behaviors and Sexually Transmitted Diseases in Sierra Leone: A Population-Based Study. Journal of Acquired Immune Deficiency Syndromes, 75, 399–407. [PubMed: 28406807]

Kelly JD, Weiser SD, & Tsai AC (2016). Proximate Context of HIV Stigma and Its Association with HIV Testing in Sierra Leone: A Population-Based Study. AIDS Behav, 20, 65–70. [PubMed: 25771909]

Kuhns LM, Hotton AL, Schneider J, Garofalo R, & Fujimoto K (2017). Use of Pre-exposure Prophylaxis (PrEP) in Young Men Who Have Sex with Men is Associated with Race, Sexual Risk Behavior and Peer Network Size. AIDS and Behavior, 21, 1376–1382. [PubMed: 28238119]

Kumbasar E, Rommey AK, & Batchelder WH (1994). Systematic Biases in Social Perception. American Journal of Sociology, 100, 477–505.

Leenders RTAJ (2002). Modeling social influence through network autocorrelation: Constructing the weight matrix. Social Networks, 24, 21–47.

Li MJ, Murray JK, Suwanteerangkul J, & Wiwatanadate P (2014). Stigma, social support, and treatment adherence among HIV-positive patients in Chiang Mai, Thailand. AIDS Education and Prevention, 26, 471–483. [PubMed: 25299810]

Link BG, & Phelan JC (2001). Conceptualizing Stigma. Annual Review of Sociology, 27, 363–385.

Link BG, & Phelan JC (2006). Stigma and its public health implications. Lancet, 367, 528–529. [PubMed: 16473129]

Little RJA, & Rubin DB (2002). Statistical Analysis with Missing Data: Wiley.

Macro, N.S.O.a.I. (2011). Malawi Demographic and Health Survey 2010. Calverton: ICF Macro.

Major B, & O'Brien LT (2005). The social psychology of stigma. Annual Review of Psychology, 56, 393–421.

Mall S, Middelkoop K, Mark D, Wood R, & Bekker LG (2013). Changing patterns in HIV/AIDS stigma and uptake of voluntary counselling and testing services: the results of two consecutive community surveys conducted in the Western Cape, South Africa. AIDS Care, 25, 194–201. [PubMed: 22694602]

Marsden PV (1987). Core discussion networks of Americans. American Sociological Review, 52, 122–131.

Marsden PV (1990). Network Data and Measurement. Annual Review of Sociology, 16, 435–463.

McPherson M, Smith-Lovin L, & Cook JM (2001). Birds of a Feather: Homophily in Social Networks. Annual Review of Sociology, 27, 415–444.

Ministry of Health, G.o.U. (2012). Uganda AIDS Indicator Survey 2011. Kampala, Uganda.

Ministry of Health/Uganda, & ICF International. (2012). Uganda AIDS Indicator Survey (UAIS) 2011. Calverton, Maryland, USA: Ministry of Health/Uganda and ICF International.

Moreno JL (1953). Who shall survive? Foundations of sociometry, group psychotherapy and socio-drama, 2nd *ed.* Oxford, England: Beacon House.

Morgan E, Skaathun B, Nikolopoulos GK, Paraskevis D, Williams LD, Smyrnov P, et al. (2018). A Network Intervention to Locate Newly HIV Infected Persons Within MSM Networks in Chicago. AIDS Behav.

Mugoya GCT, & Ernst K (2014). Gender differences in HIV-related stigma in Kenya. AIDS Care, 26, 206–213. [PubMed: 23795954]

Mulawa M, Yamanis TJ, Balvanz P, Kajula LJ, & Maman S (2016a). Comparing Perceptions with Actual Reports of Close Friend's HIV Testing Behavior Among Urban Tanzanian Men. AIDS and Behavior, 20, 2014–2022. [PubMed: 26880322]

Mulawa M, Yamanis TJ, Hill LM, Balvanz P, Kajula LJ, & Maman S (2016b). Evidence of social network influence on multiple HIV risk behaviors and normative beliefs among young Tanzanian men. Soc Sci Med, 153, 35–43. [PubMed: 26874081]

Nabukenya AM, & Matovu JKB (2018). Correlates of HIV status awareness among older adults in Uganda: results from a nationally representative survey. BMC Public Health, 18, 1128. [PubMed: 30223821]

Neuberg SL, Smith DM, & Asher T (2000). Why people stigmatize: Toward a biocultural framework The social psychology of stigma. pp. 31–61). New York, NY, US: Guilford Press.

Ng CK, & Tsai AC (2017). Proximate Context of HIV-Related Stigma and Women's Use of Skilled Childbirth Services in Uganda. AIDS Behav, 21, 307–316. [PubMed: 27106877]

O'Malley AJ, & Marsden PV (2008). The Analysis of Social Networks. Health Serv Outcomes Res Methodol, 8, 222–269. [PubMed: 20046802]

Onnela JP, Landon BE, Kahn AL, Ahmed D, Verma H, O'Malley AJ, et al. (2016). Polio vaccine hesitancy in the networks and neighborhoods of Malegaon, India. Soc Sci Med, 153, 99–106. [PubMed: 26889952]

Pantelic M, Shenderovich Y, Cluver L, & Boyes M (2015). Predictors of internalised HIV-related stigma: a systematic review of studies in sub-Saharan Africa. Health Psychol Rev, 9, 469–490. [PubMed: 25559431]

Pantelic M, Sprague L, & Stangl AL (2019). It's not "all in your head": critical knowledge gaps on internalized HIV stigma and a call for integrating social and structural conceptualizations. BMC Infectious Diseases, 19, 210. [PubMed: 30832613]

Perkins JM, Nyakato VN, Kakuhikire B, Mbabazi PK, Perkins HW, Tsai AC, Subramanian SV Christakis NA, Bangsberg DR (2018). Actual Versus Perceived HIV Testing Norms, and Personal HIV Testing Uptake: A Cross-Sectional, Population-Based Study in Rural Uganda. AIDS Behav, 22(2), 616–628. doi:10.1007/s10461-017-1691-z [PubMed: 28233075]

Perkins JM, Nyakato VN, Kakuhikire B, Tsai AC, Subramanian SV, Bangsberg DR, et al. (2018). Food insecurity, social networks and symptoms of depression among men and women in rural Uganda: a cross-sectional, population-based study. Public Health Nutr, 21, 838–848. [PubMed: 28988551]

Perkins JM, Subramanian SV, & Christakis NA (2015). Social networks and health: a systematic review of sociocentric network studies in low- and middle-income countries. Soc Sci Med, 125, 60–78. [PubMed: 25442969]

Phelan JC, & Link BG (2004). Fear of people with mental illnesses: the role of personal and impersonal contact and exposure to threat or harm. Journal of Health and Social Behavior, 45, 68–80. [PubMed: 15179908]

Project, T.K.f.H. Uganda Couples HIV Counseling and Testing.

Quinn K, & Dickson-Gomez J (2016). Homonegativity, Religiosity, and the Intersecting Identities of Young Black Men Who Have Sex with Men. AIDS Behav, 20, 51–64. [PubMed: 26373283]

Quinn K, Dickson-Gomez J, Broaddus M, & Kelly JA (2018). "It's almost like a crab-in-a-barrel situation": Stigma, social support, and engagement in care among Black men living with HIV. AIDS Educ Prev, 30, 120–136. [PubMed: 29688770]

Scambler G, & Hopkins A (1986). Being epileptic: coming to terms with stigma. Sociology of Health and Illness, 8, 26–43.

Schneider JA, Cornwell B, Ostrow D, Michaels S, Schumm P, Laumann EO, et al. (2013). Network mixing and network influences most linked to HIV infection and risk behavior in the HIV epidemic among black men who have sex with men. Am J Public Health, 103, e28–36.

Schneider JA, McFadden RB, Laumann EO, Prem Kumar SG, Gandham SR, & Oruganti G (2012). Candidate change agent identification among men at risk for HIV infection. Soc Sci Med, 75, 1192–1201. [PubMed: 22762951]

Schneider JA, Zhou AN, & Laumann EO (2015). A new HIV prevention network approach: sociometric peer change agent selection. Soc Sci Med, 125, 192–202. [PubMed: 24518188]

Shakya HB, Christakis NA, & Fowler JH (2014). Association between social network communities and health behavior: an observational sociocentric network study of latrine ownership in rural India. Am J Public Health, 104, 930–937. [PubMed: 24625175]

Shakya HB, Christakis NA, & Fowler JH (2015). Social network predictors of latrine ownership. Soc Sci Med, 125, 129–138. [PubMed: 24726688]

Shakya HB, Christakis NA, & Fowler JH (2017). An exploratory comparison of name generator content: Data from rural India. Social Networks, 48, 157–168. [PubMed: 28845086]

Shakya HB, Hughes DA, Stafford D, Christakis NA, Fowler JH, & Silverman JG (2016). Intimate partner violence norms cluster within households: an observational social network study in rural Honduras. BMC Public Health, 16, 233. [PubMed: 26951919]

Siedner MJ, Musinguzi N, Tsai AC, Muzoora C, Kembabazi A, Weiser SD, et al. (2014). Treatment as long-term prevention: sustained reduction in HIV sexual transmission risk with use of antiretroviral therapy in rural Uganda. AIDS, 28, 267–271. [PubMed: 24361683]

Siedner MJ, Ng CK, Bassett IV, Katz IT, Bangsberg DR, & Tsai AC (2015). Trends in CD4 count at presentation to care and treatment initiation in sub-Saharan Africa, 2002–2013: a meta-analysis. Clinical Infectious Diseases, 60, 1120–1127. [PubMed: 25516189]

Simbayi LC, Kalichman S, Strebel A, Cloete A, Henda N, & Mqeketo A (2007). Internalized stigma, discrimination, and depression among men and women living with HIV/AIDS in Cape Town, South Africa. Social Science and Medicine, 64, 1823–1831. [PubMed: 17337318]

Stangl AL, Lloyd JK, Brady LM, Holland CE, & Baral S (2013). A systematic review of interventions to reduce HIV-related stigma and discrimination from 2002 to 2013: how far have we come? Journal of the International AIDS Society, 16, 18734. [PubMed: 24242268]

Steward WT, Herek GM, Ramakrishna J, Bharat S, Chandy S, Wrubel J, et al. (2008). HIV-related stigma: adapting a theoretical framework for use in India. Social Science and Medicine, 67, 1225–1235. [PubMed: 18599171]

Stuber J, Galea S, & Link BG (2009). Stigma and Smoking: The Consequences of Our Good Intentions. Social Service Review, 83, 585–609.

Takada S, Weiser SD, Kumbakumba E, Muzoora C, Martin JN, Hunt PW, et al. (2014). The dynamic relationship between social support and HIV-related stigma in rural Uganda. Ann Behav Med, 48, 26–37. [PubMed: 24500077]

Tankard ME, & Paluck EL (2016). Norm Perception as a Vehicle for Social Change. Social Issues and Policy Review, 10, 181–211.

Treves-Kagan S, El Ayadi AM, Pettifor A, MacPhail C, Twine R, Maman S, et al. (2017). Gender, HIV Testing and Stigma: The Association of HIV Testing Behaviors and Community-Level and Individual-Level Stigma in Rural South Africa Differ for Men and Women. AIDS Behav, 21, 2579–2588. [PubMed: 28058565]

Tsai AC (2015). Socioeconomic Gradients in Internalized Stigma Among 4,314 Persons with HIV in Sub-Saharan Africa. AIDS Behav, 19, 270–282. [PubMed: 25572833]

Tsai AC, Bangsberg DR, Emenyonu N, Senkungu JK, Martin JN, & Weiser SD (2011). The social context of food insecurity among persons living with HIV/AIDS in rural Uganda. Social Science and Medicine, 73, 1717–1724. [PubMed: 22019367]

Tsai AC, Bangsberg DR, Frongillo EA, Hunt PW, Muzoora C, Martin JN, et al. (2012). Food insecurity, depression and the modifying role of social support among people living with HIV/AIDS in rural Uganda. Social Science and Medicine, 74, 2012–2019. [PubMed: 22513248]

Tsai AC, Bangsberg DR, Kegeles SM, Katz IT, Haberer JE, Muzoora C, et al. (2013a). Internalized stigma, social distance, and disclosure of HIV seropositivity in rural Uganda. Annals of Behavioral Medicine, 46, 285–294. [PubMed: 23690283]

Tsai AC, Bangsberg DR, & Weiser SD (2013b). Harnessing poverty alleviation to reduce the stigma of HIV in Sub-Saharan Africa. PLoS Med, 10, e1001557. [PubMed: 24319400]

Tsai AC, Kakuhikire B, Mushavi R, Vorechovska D, Perkins JM, McDonough AQ, et al. (2016). Population-based study of intra-household gender differences in water insecurity: reliability and validity of a survey instrument for use in rural Uganda. J Water Health, 14, 280–292. [PubMed: 27105413]

Tsai AC, & Venkataramani AS (2015). The causal effect of education on HIV stigma in Uganda: Evidence from a natural experiment. Social Science and Medicine, 142, 37–46. [PubMed: 26282707]

Tsai AC, Weiser SD, Steward WT, Mukiibi NF, Kawuma A, Kembabazi A, et al. (2013c). Evidence for the Reliability and Validity of the Internalized AIDS-Related Stigma Scale in Rural Uganda. AIDS Behav, 17, 427–433. [PubMed: 22869104]

Turan B, Budhwani H, Fazeli PL, Browning WR, Raper JL, Mugavero MJ, et al. (2017a). How Does Stigma Affect People Living with HIV? The Mediating Roles of Internalized and Anticipated

HIV Stigma in the Effects of Perceived Community Stigma on Health and Psychosocial Outcomes. AIDS Behav, 21, 283–291. [PubMed: 27272742]

Turan B, Hatcher AM, Weiser SD, Johnson MO, Rice WS, & Turan JM (2017b). Framing Mechanisms Linking HIV-Related Stigma, Adherence to Treatment, and Health Outcomes. American Journal of Public Health, 107, 863–869. [PubMed: 28426316]

Turan JM, Bukusi EA, Onono M, Holzemer WL, Miller S, & Cohen CR (2011). HIV/AIDS stigma and refusal of HIV testing among pregnant women in rural Kenya: results from the MAMAS Study. AIDS Behav, 15, 1111–1120. [PubMed: 20827573]

Turan JM, Hatcher AH, Medema-Wijnveen J, Onono M, Miller S, Bukusi EA, et al. (2012). The role of HIV-related stigma in utilization of skilled childbirth services in rural Kenya: a prospective mixed-methods study. PLoS Med, 9, e1001295. [PubMed: 22927800]

Turan JM, Miller S, Bukusi EA, Sande J, & Cohen CR (2008). HIV/AIDS and maternity care in Kenya: how fears of stigma and discrimination affect uptake and provision of labor and delivery services. AIDS Care, 20, 938–945. [PubMed: 18777222]

Turan JM, & Nyblade L (2013). HIV-related stigma as a barrier to achievement of global PMTCT and maternal health goals: a review of the evidence. AIDS Behav, 17, 2528–2539. [PubMed: 23474643]

Valente TW (2012). Network interventions. Science, 337, 49–53. [PubMed: 22767921]

Vanable PA, Carey MP, Blair DC, & Littlewood RA (2006). Impact of HIV-related stigma on health behaviors and psychological adjustment among HIV-positive men and women. AIDS Behav, 10, 473–482. [PubMed: 16604295]

VanderWeele TJ, & Ding P (2017). Sensitivity Analysis in Observational Research: Introducing the *E*-Value. Annals of Internal Medicine, 167, 268–274. [PubMed: 28693043]

Varas-Diaz N, Neilands TB, Malave Rivera S, & Betancourt E (2010). Religion and HIV/AIDS stigma: implications for health professionals in Puerto Rico. Glob Public Health, 5, 295–312. [PubMed: 20087809]

Visser MJ, Kershaw T, Makin JD, & Forsyth BWC (2008). Development of Parallel Scales to Measure HIV-Related Stigma. AIDS Behav, 12, 759–771. [PubMed: 18266101]

Wolfe WR, Weiser SD, Leiter K, Steward WT, Percy-de Korte F, Phaladze N, et al. (2008). The Impact of Universal Access to Antiretroviral Therapy on HIV Stigma in Botswana. American Journal of Public Health, 98, 1865–1871. [PubMed: 18703447]

Yamanis TJ, Fisher JC, Moody JW, & Kajula LJ (2016). Young Men's Social Network Characteristics and Associations with Sexual Partnership Concurrency in Tanzania. AIDS Behav, 20, 1244–1255. [PubMed: 26271813]

Yang H, Li X, Stanton B, Fang X, Lin D, & Naar-King S (2006). HIV-related knowledge, stigma, and willingness to disclose: A mediation analysis. AIDS Care, 18, 717–724. [PubMed: 16971280]

Yang LH, & Kleinman A (2008). 'Face' and the embodiment of stigma in China: the cases of schizophrenia and AIDS. Social Science and Medicine, 67, 398–408. [PubMed: 18420325]

Youssef E, Wright J, Delpech V, Davies K, Brown A, Cooper V, et al. (2018). Factors associated with testing for HIV in people aged >/=50 years: a qualitative study. BMC Public Health, 18, 1204. [PubMed: 30367609]

Zelner JL, Trostle J, Goldstick JE, Cevallos W, House JS, & Eisenberg JN (2012). Social connectedness and disease transmission: social organization, cohesion, village context, and infection risk in rural Ecuador. Am J Public Health, 102, 2233–2239. [PubMed: 23078481]

Zou J, Yamanaka Y, John M, Watt M, Ostermann J, & Thielman N (2009). Religion and HIV in Tanzania: influence of religious beliefs on HIV stigma, disclosure, and treatment attitudes. BMC Public Health, 9, 75. [PubMed: 19261186]

Highlights

1. HIV-related stigma affects the wellbeing of people living with HIV
2. We collected complete social network in rural Uganda
3. The network autocorrelation model was used to estimate associations
4. Egos' stigma was positively correlated with alters' stigma
5. Egos' stigma was negatively correlated with having HIV-positive alters

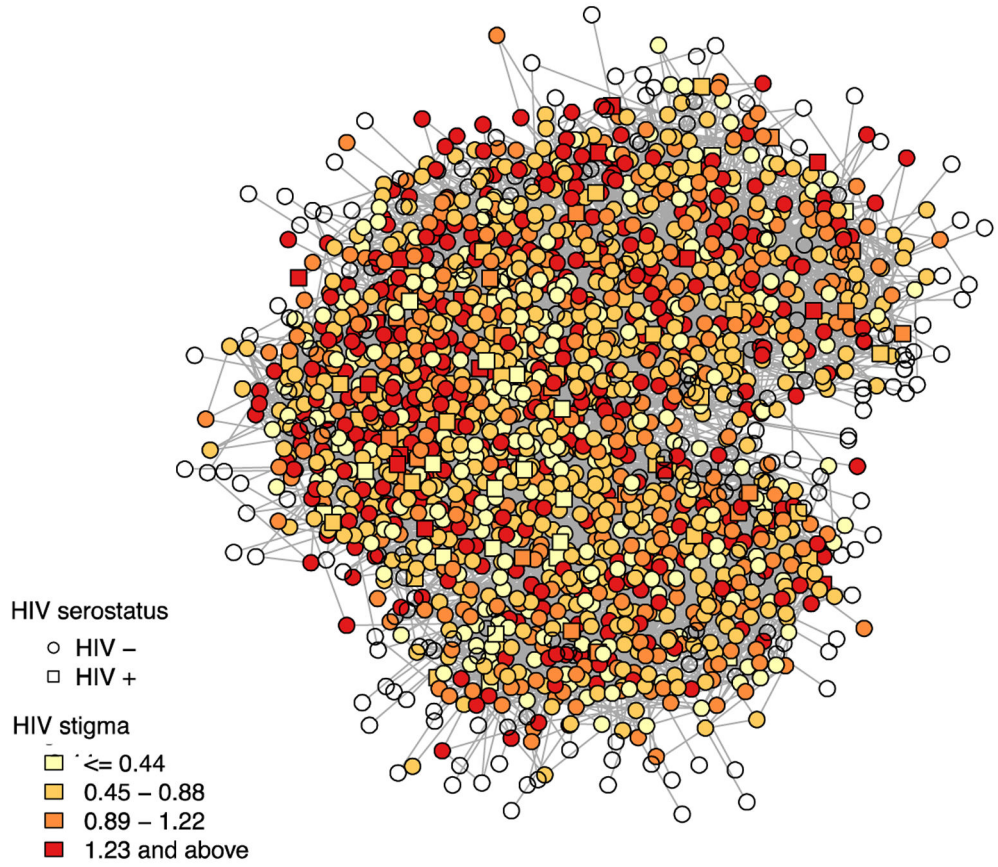

Fig. 1.
Social network graph of the Nyakabare Parish population.

Table 1.

Summary statistics ($N = 1669$)

	Mean or *N*	*SD* or Percent
Individual Variables		
Age		
Less Than 30 Years	694	42%
30 - 39 Years	330	20%
40 – 49 Years	266	16%
50 – 59 Years	134	8%
60 Years or More	230	14%
Sex		
Female	913	58%
Male	707	42%
Marital Status		
Married	935	57%
Divorced/Separated	269	16%
Single	436	27%
Religion		
Catholic	407	24%
Protestant	1148	69%
Other	79	5%
Household Asset Quintile		
Poorest	273	16%
Less Poor	316	19%
Middle	327	20%
Richer	383	23%
Richest	370	22%
Education		
Less than Primary School Completion	1143	68%
Completed Primary School	508	30%
HIV positive	116	7%
Perceives HIV Prevalence as >50%	503	30%
AIDS-Related Stigma Scale	0.79	0.50
Network Variables		
Number of Alters	9.77	5.52
Eigenvector Centrality	0.040	0.074
Presence of an HIV-Positive Alter	757	46%
Mean Stigma Score of Alters	0.76	0.25

Column percentages within categories may not add to 100% due to missing data

Table 2.

Correlates of egos' HIV-related stigma ($N = 1648$).

	Unadjusted	Model 1	Model 2
	***b* (95% *CI*)**	***b* (95% *CI*)**	***b* (95% *CI*)**
Intercept		0.034 (0.024, 0.044)***	−0.004 (−0.015, 0.008)
Individual Variables			
Age	0.016 (0.014, 0.017)***	0.004 (0.002, 0.006)**	0.001 (−0.001, 0.003)
Sex			
Female	Ref	Ref	Ref
Male	0.564 (0.493, 0.635)***	0.071 (0.007, 0.134)*	0.014 (−0.039, 0.066)
Marital Status			
Single	0.488 (0.416, 0.559)***	0.085 (0.014, 0.156)*	0.000 (−0.067, 0.066)
Divorced, Separated	0.347 (0.209, 0.486)***	0.007 (−0.075, 0.090)	0.007 (−0.072, 0.087)
Married	Ref	Ref	Ref
Religion			
Catholic	0.782 (0.719, 0.844)***	0.485 (0.389, 0.582)***	0.155 (0.053, 0.256)**
Protestant	0.774 (0.732, 0.816)***	0.489 (0.409, 0.570)***	0.166 (0.076, 0.257)***
Other	Ref	Ref	Ref
Asset Index	0.180 (0.166, 0.193)***	0.038 (0.018, 0.057)***	0.003 (−0.015, 0.022)
Education			
Less than Primary School Completion			
Completed Primary School	0.288 (0.220, 0.356)***	−0.049 (−0.110, 0.013)	−0.072 (−0.130, −0.014)*
HIV Positive	0.142 (0.014, 0.270)*		−0.065 (−0.162, 0.032)
Perceives HIV Prevalence as >50%	0.335 (0.272, 0.397)***		0.054 (0.002, 0.106)*
Population in cell	0.004 (0.003, 0.004)***		0.001 (0.000, 0.001)*
Network Variables			
Eigenvector Centrality	5.297 (0.670, 9.923)*		0.134 (−0.204, 0.472)
Presence of an HIV-Positive Alter	0.258 (0.016, 0.314)***		−0.053 (−0.104, −0.003)*
Mean Stigma Score of Alters	0.977 (0.946, 1.008)***		0.527 (0.423, 0.630)***

*$p<0.05$;

**$p< 0.01$;

***$p< 0.001$