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Is social capital associated with HIV risk in rural South Africa?☆

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Abstract

The role of social capital in promoting health is now widely debated within international public health. In relation to HIV, the results of previous observational and cross-sectional studies have been mixed. In some settings it has been suggested that high levels of social capital and community cohesion might be protective and facilitate more effective collective responses to the epidemic. In others, group membership has been a risk factor for HIV infection. There have been few attempts to strengthen social capital, particularly in developing countries, and examine its effect on vulnerability to HIV. Employing data from an intervention study, we examined associations between social capital and HIV risk among 1063 14 to 35-year-old male and female residents of 750 poor households from 8 villages in rural Limpopo province, South Africa. We assessed cognitive social capital (CSC) and structural social capital (SSC) separately, and examined associations with numerous aspects of HIV-related psycho–social attributes, risk behavior, prevalence and incidence. Among males, after adjusting for potential confounders, residing in households with greater levels of CSC was linked to lower HIV prevalence and higher levels of condom use. Among females, similar patterns of relationships with CSC were observed. However, while greater SSC was associated with protective psychosocial attributes and risk behavior, it was also associated with higher rates of HIV infection. This work underscores the complex and nuanced relationship between social capital and HIV risk in a rural African context. We suggest that not all social capital is protective or health promotive, and that getting the balance right is critical to informing HIV prevention efforts.

Keywords: South Africa; Social capital; HIV; Intervention study; Prevention; Men; Woman

Introduction

Over the past decade, South Africa has witnessed one of the fastest growing HIV epidemics in the world. Between 1992 and 2005, HIV prevalence among antenatal clinic attenders has increased by more than 10-fold, from 2.4 to 30.2% (Department of Health, 2005). Since 2002, death from AIDS has outstripped all other causes of adult mortality combined (Dorrington, Bourne, Bradshaw, Laubscher, & Timaeus, 2001).

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There is an evolving literature that attempts to explain why some countries or communities have more HIV than others. The 'risk environment' defines aspects of social situations that are largely outside individuals' control yet have a major effect on the level of disease in populations (Rhodes, Singer, Bourgois, Friedman, & Strathdee, 2005; Rose, 1985). In South Africa, major elements of the risk environment thought to fuel vulnerability to HIV include poverty and underdevelopment in the setting of extreme social and economic inequality; the high rates of labour migration; and entrenched gender inequalities where physical and sexual violence against women and girls are commonplace (Fenton, 2004; Garcia-Moreno & Watts, 2000; Gilbert & Walker, 2002; Mane, Gupta, & Weiss, 1994; Parker, Easton, & Klein, 2000; Rao Gupta, 2002; UNAIDS, 1999, 2002). Taken together, these factors interact to underpin the severity and scale of the HIV epidemic.

Social capital has been put forth as a conceptual framework to link the risk environment to a host of individual health outcomes including HIV (Berkman & Kawachi, 2001; Szreter & Woolcock, 2004). It has been defined as the ''features of social organization, such as trust, norms and networks that can improve the efficiency of society by facilitating coordinated action'' (Putnam et al., 1993).

There are a number of mechanisms through which social capital might affect the prevalence and distribution of HIV in populations (Berkman & Kawachi, 2001; Campbell & MacPhail, 2002; Campbell, Williams, & Gilgen, 2002; Gregson, Terceira, Mushati, Nyamukapa, & Campbell, 2004; Veenstra, 2000). At a very basic level, non-random mixing within high-risk 'core-groups' – such as intravenous drug users or sex workers, contributed to much of HIV transmission early on in the epidemic (Mann & Tarantola, 1996). However, well-functioning community networks and the social and material resources that flow between them may also carry protective effects. Strong social networks may exert social or cultural pressure in ways that deter high-risk sexual activity. In addition to providing avenues for the exchange of information, these networks may shape community norms around gender relations, communication and sexual negotiation. They may provide role modelling for health-promotive behavior – such as condom use or access to HIV testing. Individuals with wider networks and deeper trust relationships may have a stronger sense of self-confidence, self esteem and may be better able to take control over decision making. The emotional support generated around these networks may reduce discrimination around HIV and create a more accepting environment for those living with the disease. Finally, more cohesive social and geographic communities may be better able to take collective action and respond to common priority issues such as HIV/AIDS.

Social capital and HIV prevention

Better understanding the relationship between social capital and HIV risk thus has potential to influence and inform prevention activities (Poundstone, Strathdee, & Celentano, 2004). Perhaps, the most compelling observational work to date in this regard comes from two very diverse contexts where epidemic control has been remarkably successful. There was an eight-fold reduction in new HIV infection rates among gay men in San Francisco over a 4-year period relatively early in the epidemic. Wohlfeiler notes that ''most of the behavior change took place very quickly, and to a large degree was simultaneous with the establishment of AIDS prevention agencies, rather than a result of those efforts'' (Wohlfeiler, 2002). He attributes much of this decline to effective mobilization efforts, notably, among an educated, socially active and well-resourced community facing a direct and immediate threat. Furthermore, public health initiatives were formulated through substantial consultation and involvement of the gay community itself.

The second example comes from Uganda where reductions in antenatal HIV prevalence from 30 to under 10% were observed between 1990 and 2005 – reductions that were not witnessed in neighbouring countries such as Kenya where the epidemic was of similar severity (Green, 2003). It has been suggested that effective social mobilization, particularly through peer-to-peer networks, critically underpinned the dramatic reductions in prevalence (Epstein, 2007). The effect of these dynamics was felt to be 'equivalent to a highly effective vaccine' (Stoneburner & Low-Beer, 2004). Again, such efforts largely preceded widespread implementation of conventional prevention measures such as condom distribution, voluntary counselling and testing services, and the syndromic management of sexually transmitted infections (STI).

In contrast, a lack of social capital may serve to exacerbate HIV infection and limit the effectiveness of control efforts. In her post-mortem of an intensive program to reduce HIV transmission in and around a mining community in South Africa, Campbell noted how the absence of community cohesion and the

transformation of social and sexual norms associated with chronic poverty and dislocation played a major role in limiting the impact of an ambitious and well-conceived intervention program (Campbell, 2003).

Despite its promise, the application of social capital discourse to framing and responding to public health challenges such as HIV/AIDS remains at a very early stage. Few studies have empirically examined social capital as an explicit component of the HIV risk environment. Cross-sectional research from the US drawing upon state-wide social capital measures have noted inverse associations with STI rates, including AIDS (Holtgrave & Crosby, 2003). Others have demonstrated associations between social capital proxies, such as the density of broken windows in a neighbourhood, and rates of gonorrhoea (Cohen et al., 2000). In Southern Africa, cross-sectional research from Zimbabwe and South Africa suggests that while membership in some social groups is associated with lower rates of HIV, membership in others seems to exacerbate the risk of infection (Campbell et al., 2002; Gregson et al., 2004).

While these studies are exploratory, they raise intriguing questions regarding the temporal and causal nature of such relationships and the potential mechanisms through which social capital might affect HIV risk. In reflecting on the need to advance the rigour of this emerging evidence base, a number of authors have highlighted common limitations to previous research, suggesting critical directions for future work (De Silva, McKenzie, Harpham, & Huttly, 2004; Harpham, Grant, & Thomas, 2002; Macinko & Starfield, 2001; Szreter & Woolcock, 2004).

- Despite over a decade's experience, there is *no universally accepted way to measure social capital*. Social capital assessments have often relied upon indicators from surveys designed for a different purpose. To address these concerns, there is emerging consensus that social capital assessments should capture both structural (aspects of social group membership) and cognitive dimensions (perceptions of trust, solidarity, and reciprocity in one's community), and should attempt to ensure these measures are locally appropriate and valid.
- Research questions should be underpinned by a *clear theoretical and conceptual base*
- *Few longitudinal studies exist*, to allow for a more definitive exploration of causal relationships and mechanisms of action.
- The *effects of mediating and confounding* variables have been poorly addressed.
- Finally, few intervention studies exist, alongside a paucity of research from developing counties.

In this study, we attempt to address a number of these shortcomings in examining the relationship between social capital and HIV/AIDS in a rural South African context. The research took place within the Intervention with Microfinance for AIDS and Gender Equity (IMAGE Study), a randomized trial that explored the effect of a combined microfinance and training program on HIV risk and levels of intimate partner violence (IPV) (Pronyk et al., 2006). The intervention was offered to groups of women and aimed to generate social capital through stimulating participation in social networks, enhancing solidarity, and mobilizing communities around priority concerns including HIV/AIDS. The dataset allows for a detailed assessment of both cognitive and structural dimensions of social capital alongside numerous psychosocial, behavioral and biological aspects of HIV risk. The paper examines the nature and strength of these associations, and explores wider implications for policy and practice.

Methodology

Setting and sampling frame

This study was set among eight villages in South Africa's rural Limpopo Province. The area was densely settled with a total population of approximately 60,000, and is adjacent to a platinum mining belt. Study villages were between 2 and 20 km from a main trading centre. Poverty was widespread (Rose & Charlton, 2003) with high levels of circular labour migration (Collinson, Tollman, Kahn, Clark, & Garenne, 2006). Forty percent of households were female headed and the average household size was seven people. Few households had land or livestock sufficient to support livelihoods. One-third of adults were unemployed and the major source of income was government grants including pensions and child-support.

Approximately 10% of households in each village were sampled. Households enrolled in this study included those participating in a microfinance-based intervention and matched households from comparison villages selected at random. All were among the poorest in their village, as assessed by participatory wealth ranking (Hargreaves et al., 2007), and detailed field procedures are described elsewhere (Pronyk et al., 2006). Cross-sectional data used in this analysis were collected during 2004, after the introduction of the microfinance intervention, as it contained information on

HIV incidence; and greater variation in levels of social capital allowed for more robust statistical testing of associations.

Theoretical framework linking social capital and HIV risk

Fig. 1 outlines the theoretical framework linking social capital and HIV, with exposure and outcome variables listed in Table 1.

Social capital

Household levels of social capital were assessed through interviews with senior female respondents (average age 42 years). The assessment of social capital has been drawn from the World Bank's Social Capital Assessment Tool and related literature (Grootaert, Narayan, Jones, & Woolcock, 2003; Harpham et al., 2002; Krishna & Shrader, 1999). Levels of social capital were assessed as follows:

Structural social capital (SSC)

- Group membership and the level or intensity of membership

$$\mathrm{SSC} = \beta(g1) + \beta(g2) + \beta(g3) + \ldots$$

where β is the multiplier for intensity of group membership (1 = member, 2 = active/regular attender, 3 = group leader) and gx is the specific social group (derived from a pre-coded list of 18 potential groups). For SSC, a binary variable was constructed to reflect households below and above median values.

Cognitive social capital (CSC). A variable was constructed for CSC based on responses to nine questions (Table 1) from the following thematic areas:

- Perceived levels of reciprocity and community support
- Perceived solidarity in response to a crisis event
- Participation in collective action

A binary variable was constructed for CSC from a composite where those scoring positive responses to 2/3 or greater of the thematic areas listed were considered households with higher levels of CSC.

HIV risk

HIV risk was assessed among a largely independent group of 14 to 35-year-old male and female household members – those at greatest risk of infection. HIV-related outcomes were derived from responses to questions in Table 1 based on a number of psychosocial attributes that might influence sexual decision

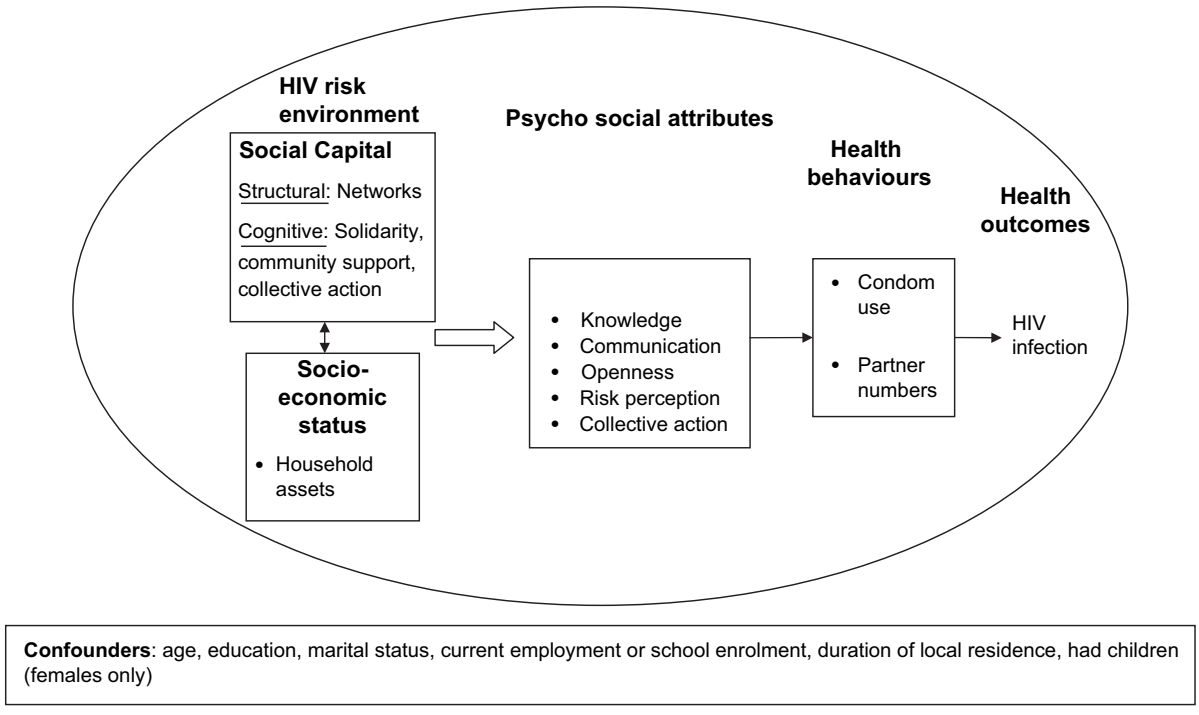

Fig. 1. Theoretical framework: social capital and HIV risk.

Table 1
Outcome variables

Exposure variables: social capital	
	Question
Structural/SSC	
Social network Score (Score derived from group member × intensity multiplier)	List of 18 potential community groups including: religious affiliations (churches, burial societies and prayer groups), economic groups, political groups, sports teams, cultural groups and other civil society organizations. Intensity of Membership: member (1), active member (2), group leader (3)
Cognitive/CSC	
Perceived Reciprocity and Community support (Positive response: yes to any or all)	If a community project does not directly benefit your neighbor but has benefits for others in the village/neighborhood, do you think your neighbor would contribute time for this project? *Yes or no* If a community project does not directly benefit your neighbor but has benefits for others in the village/neighborhood, would your neighbor contribute money (say about 10R) for this project? *Yes or no* If there were a problem that affected the entire village/neighborhood, for instance lack of water or electricity or a major flood, which scenario do you think would best describe who would work together to deal with the situation? *Yes if the entire village would work together to solve the problem*
Perceived Solidarity in a Crisis (Positive response: yes to any or all)	If your house has been destroyed by fire who could you turn to for shelter for 2 weeks? *Yes if you could turn to people you do not know at all* If your house has been destroyed by fire who could you turn to for (money) R50 ($7US) to help you buy clothes after the fire? *Yes if you could turn to people you do not know at all* How confident are you that you alone could raise enough money to feed your family for four weeks? – this could be for example by working, selling things that you own, or by borrowing money (from people you know or from a bank or money lender? *Yes if very confident* Would you say that your household's ability to survive this kind of crisis is better, the same or worse as it was 2 years ago? *Better or worse/same*
Collective action (Positive response: yes to one or both)	In the past 2 years, have you participated in a meeting, march, rally or gathering around HIV/AIDS awareness? *Yes or no* Have you ever been involved in the organization of such a meeting or gathering? *Yes or no*
Outcome variables: HIV risk	
Psycho–social attributes (Positive response to the following questions)	
Knowledge	A healthy looking person can be HIV positive.
Openness	You feel free and open to discuss sex and sexuality in your household.
Communication	In the past year, you have communicated with parents/household members about sex or sexuality?
Risk perception	You consider yourself to be at high/medium, risk of acquiring HIV infection
Collective Action in young people	In the past 3 years you have participated in a meeting, march, rally or gathering on HIV/AIDS. You have been involved in the organization of such a meeting or gathering.
Sexual behavior	Condom use the last time you had sex with [a non-spousal partner]? (up to 3 listed) In the last 12 months, you always or more than half the time use condoms when having sex with [a non-spousal partner] Numbers of partners in the past year
Biological outcomes	HIV prevalence at follow-up HIV incidence

making and behavior, including partner number and condom use with non-spousal partners. Of note, in this cohort of young people, collective action was also included as an HIV-related outcome, as it reflects participation in a potential awareness raising and risk-reduction activity. HIV prevalence was determined using oral-mucosal transudate specimens (OraSure UCB group, Belgium) and HIV incidence was measured based on repeated sampling after 2 years of observation.

Confounding factors were conceptually derived based on previous work highlighting variables with the potential to affect both social capital and HIV risk yet are not directly on the causal pathway between them. As such, the effects of age, education level, marital status, current employment or school enrolment, having had children in females, and the duration of local residence were all adjusted for in the analysis (Berkman & Glass, 2000; Bolin, Lindgren, Lindstrom, & Nystedt, 2003; Drukker, Buka, Kaplan, McKenzie,

& Van Os, 2005; Jewkes, Levin, & Penn-Kekana, 2002). Socioeconomic status (SES) was also examined as a confounder and was assessed through determining the value of a select list of non-fixed household assets.

Validity and internal reliability of social capital indicators

Extensive local piloting of survey tools was conducted over a 3-month period in 2001. Indicators captured numerous dimensions of structural and cognitive social capital, were derived from best practice tools, and were supported by feedback from field researchers to ensure questions and response codes were locally appropriate and well understood by interviewers and respondents.

Cronbach's alpha was used to assess internal reliability and the potential to combine responses from several survey questions into single numerical values (Bland & Altman, 1997). Reliability coefficients were: 0.55 for community support, 0.6 for solidarity, and 0.7 for collective action, which approached threshold values for internal validity. A composite variable for CSC was thus constructed including the three subcomponents above.

Internal reliability for a composite value that attempted to bring together indicators of structural and cognitive social capital was low (0.31). Further analyses, therefore, examined relationships with each dimension separately. Previous research has suggested SSC and CSC indeed measure different things and often have different relationships with health outcomes (De Silva et al., 2004).

Statistical analysis

All data were entered into a Microsoft Access database containing a range of logic checks. Statistical analysis was conducted using Stata version 9.

Relationships between social capital and HIV risk were assessed using cross-sectional data at follow-up derived from all households under study. Research questions pertained to whether, across the study site, associations existed between household levels of SSC/CSC and HIV risk among young people living there. The hypothesis was that young people residing in households with higher levels of social capital would be at lower HIV risk. Furthermore, it was hypothesized that either high levels of pre-existing social capital (with potentially little room for measurable improvement) or recent strengthening of social capital stocks would both be protective. Both are captured as households with higher levels of CSC and/or SSC in the follow-up data employed in this analysis.

All analyses were conducted for males and females separately. Bi-variate models present crude odds ratios (OR) and 95% confidence intervals for all associations. Two multivariate logistic regression models further examined the effect of mediating and confounding. The first model examined the role of potential confounders including SES. A term for village pair was also included to adjust for potential village level clustering of associations (Model 1).

As the data employed for this analysis were collected during an intervention trial, a final model was created to adjust for the presence of the microfinance-based intervention (Model 2). This allowed an assessment of whether relationships between social capital and HIV risk existed independent of exposure to the intervention.

Results

Response rates in this study were above 90%. Numbers vary for some associations due to missing data for some indicators, reflecting individuals without a non-spousal partner in the previous 12 months, those who refused HIV testing, or who were HIV positive at baseline and thus not included in the assessment of HIV incidence.

Associations between social capital and HIV risk

Males

Table 2 presents crude and adjusted models for 375 14 to 35-year-old male members of 750 households. After adjusting for potential confounders (Model 1), male members of households with higher levels of CSC were associated with protective psychosocial characteristics and patterns of condom use, and were less likely to be HIV positive. There were no significant associations between household SSC and HIV risk among males.

All significant associations with CSC from Model 1 were maintained after adjusting for the effects of the intervention in Model 2. Therefore, independent of effects of household exposure to the microfinance and training intervention, young men from households with higher levels of CSC had lower HIV prevalence, more protective patterns of condom use, were more open to talk about sex in the home, and perceived themselves to be at lower risk of HIV. The fact that there was little change in most aOR's between Model 1 and 2 further suggests limited intervention effects on associations in this group.

Table 2
Associations between Social Capital and HIV risk at follow-up – males (total $n = 375$)

Associations with cognitive social capital/CSC (exposure)									
Outcomes[a]		*r/n* (%)				Model 1[b]		Model 2[c]	
	n	Greater CSC	Less CSC	OR	95% CI	aOR	95% CI	aOR	95% CI
Health/behavioral outcome									
HIV prevalence	311	12/172 (7)	17/139 (12.2)	0.54	0.24–1.17	0.4	0.16–1.00	0.39	0.15–0.99
HIV incidence	264	5/150 (3.3)	9/114 (7.9)	0.40	0.12–1.23	0.52	0.15–1.83	0.51	0.14–1.76
Condom use last sex	234	66/139 (47.5)	34/95 (35.8)	1.62	0.95–2.77	1.95	1.04–3.62	2.15	1.11–4.14
Consistent condom use	234	46/139 (33.1)	18/95 (19)	2.11	1.13–3.94	2.3	1.12–4.63	2.4	1.13–5.06
Low partner number(0–2)	340	167/194 (86.1)	134/146 (92)	0.55	0.27–1.13	0.59	0.26–1.31	0.58	0.25–1.35
Psychosocial Attributes									
Greater knowledge	340	154/194 (79.4)	107/146 (73.2)	1.4	0.84–2.32	1.13	0.62–2.05	0.89	0.47–1.67
Better Communication	327	73/191 (38.2)	40/136 (29.4)	1.48	0.92–2.37	1.23	0.72–2.11	0.93	0.51–1.68
Greater openness	329	107/188 (56.9)	47/141 (33.3)	2.64	1.67–4.15	2.39	1.38–4.11	2.18	1.24–3.82
Higher self-perceived risk	337	64/191 (33.5)	76/146 (52.1)	0.46	0.30–0.72	0.44	0.26–0.72	0.44	0.26–0.74
More collective action	340	99/194 (51)	61/146 (41.8)	1.45	0.94–2.23	1.15	0.7–1.87	1.02	0.61–1.69
Associations with Structural Social Capital/SSC (exposure)									
Outcomes[a]		*r/n* (%)				Model 1[b]		Model 2[c]	
	n	Greater SSC	Less SSC	OR	95% CI	aOR	95% CI	aOR	95% CI
Health/behavioral outcome									
HIV prevalence	312	16/183 (8.7)	13/129 (10.1)	0.85	0.36–1.84	0.66	0.26–1.70	0.65	0.24–1.7
HIV incidence	265	8/161 (4.98)	6/104 (5.7)	0.85	0.28–2.5	0.6	0.15–2.4	0.57	0.13–2.38
Condom use last sex	234	58/143 (40.6)	42/91 (46.2)	0.80	0.47–1.35	0.89	0.49–1.63	0.91	0.48–1.74
Consistent condom use	234	39/143 (27.3)	25/91 (27.5)	0.99	0.54–1.78	0.95	0.49–1.85	0.89	0.44–1.82
Low partner number (0–2)	341	176/200 (88)	126/141 (89.4)	0.87	0.44–1.73	0.78	0.36–1.66	0.8	0.34–1.82
Psychosocial attributes									
Greater knowledge	341	159/200 (79.5)	103/141 (73.1)	1.43	0.86–2.37	1.24	0.68–2.24	0.87	0.46–1.67
Better Communication	328	65/194 (33.5)	49/134 (36.6)	0.87	0.55–1.39	1.02	0.61–1.72	0.7	0.38–1.26
Greater openness	330	97/196 (49.5)	58/134 (43.3)	1.28	0.82–2.0	1.46	0.86–2.5	1.21	0.67–2.17
Higher self-perceived risk	338	82/198 (41.4)	59/140 (42.1)	0.97	0.63–1.5	0.84	0.51–1.39	0.92	0.52–1.57
More collective action	341	100/200 (50)	61/141 (43.3)	1.31	0.85–2.02	1.41	0.86–2.32	1.2	0.70–2.1

[a] Numbers vary due to missing data for some outcomes.
[b] Adjust for age group, village pair, SES, marriage, local residence, education level, current work/study status.
[c] Adjust for Model 1 plus presence of the IMAGE intervention.

Females

Table 3 presents crude and adjusted models for 688 female members of 750 households. Within this group, 102 (14.8%) had direct exposure to the IMAGE intervention. After adjusting for potential confounding factors (Model 1), females residing in households with greater CSC had higher levels of consistent condom use, better communication, were more open to discuss sex in the home, and were more frequently involved in collective mobilization efforts.

In contrast to males, there were a number of significant associations between SSC and HIV risk in females. After adjusting for confounders (Model 1), females residing in households with higher levels of SSC had more protective patterns of condom use. There was also evidence of better communication, greater openness to discuss sex and higher levels of collective action. However, conversely, there was also evidence to suggest higher levels of SSC were associated with higher HIV prevalence and incidence.

After including a term for the intervention in Model 2, thus removing its effect on observed associations, only the associations between CSC and greater openness and collective action maintained significance. For SSC, protective relationships with consistent condom use were maintained, as were associations with higher HIV prevalence and incidence.

Discussion

This study suggests that in a rural South African context, social capital has important bearing on HIV risk in ways that are both complex and nuanced. Among males, residing in households with greater

Table 3
Associations between social capital and HIV risk at follow-up – females (total $n = 688$)

Associations with cognitive social capital/CSC (exposure)									
Outcomes[a]		*r/n* (%)				Model 1[b]		Model 2[c]	
	n	Greater CSC	Less CSC	OR	95% CI	aOR	95% CI	aOR	95% CI
Health/behavioral outcome									
HIV prevalence	565	64/349 (18.3)	39/216 (18.1)	1.01	0.65–1.58	0.84	0.52–1.41	0.97	0.57–1.65
HIV incidence	473	24/289 (8.3)	17/184 (9.2)	0.89	0.46–1.71	0.88	0.44–1.82	1.03	0.48–2.25
Condom use last sex	427	102/268 (38.1)	3/159 (33.3)	1.23	0.81–1.85	1.09	0.68–1.79	0.82	0.48–1.40
Consistent condom use	427	65/269 (24.2)	21/158 (13.3)	2.07	1.21–3.56	1.95	1.03–3.69	1.23	0.60–2.56
Low partner number (0/1)	638	359/396 (90.7)	223/242 (92.2)	0.83	0.46–1.47	0.94	0.48–1.83	0.93	0.45–1.9
Psychosocial attributes									
Greater knowledge	638	333/396 (84.1)	188/242 (77.7)	1.52	1.01–2.27	1.27	0.79–2.04	1.22	0.74–2.02
Better Communication	598	176/374 (47.1)	72/224 (32.1)	1.87	1.32–2.65	2.0	1.31–3.07	1.45	0.92–2.31
Greater openness	626	278/391 (71.1)	109/235 (46.4)	2.84	2.03–3.98	2.74	1.81–4.13	2.43	1.57–3.76
Higher self-perceived risk	630	197/393 (50.1)	132/237 (55.7)	0.8	0.58–1.10	0.87	0.60–1.27	0.83	0.56–1.26
More collective action	638	241/396 (60.9)	80/242 (33.1)	3.14	2.25–4.4	3.22	2.18–4.76	2.6	1.72–3.9
Associations with structural social capital/SSC (exposure)									
Outcomes[a]		*r/n* (%)				Model 1[b]		Model 2[c]	
	N	Greater SSC	Less SSC	OR	95% CI	aOR	95% CI	aOR	95% CI
Health/behavioral outcome									
HIV prevalence	566	66/320 (20.6)	37/246 (15)	1.46	0.94–2.28	1.49	0.89–2.5	1.83	1.04–3.2
HIV incidence	474	30/270 (11.1)	11/204 (5.4)	2.19	1.07–4.49	2.15	0.95–4.88	2.9	1.2–7.1
Condom use last sex	429	97/239 (40.6)	58/190 (30.5)	1.55	1.03–2.32	1.75	1.1–2.77	1.45	0.87–2.44
Consistent condom use	429	60/239 (25.1)	25/190 (13.2)	2.21	1.33–3.69	2.78	1.52–5.09	2.04	1.02–4.06
Low partner number (0/1)	642	320/351 (91.2)	265/291 (91.1)	1.01	0.58–1.75	1.08	0.57–2.05	1.09	0.55–2.17
Psychosocial attributes									
Greater knowledge	642	288/351 (82.1)	235/291 (80.8)	1.09	0.73–1.62	0.92	0.58–1.46	0.84	0.51–1.37
Better Communication	602	151/337 (44.8)	99/265 (37.4)	1.36	0.98–1.89	1.67	1.11–2.5	1.13	0.71–1.77
Greater openness	630	226/347 (65.1)	165/283 (58.3)	1.33	0.96–1.85	1.61	1.08–2.41	1.32	0.85–2.04
Higher self-perceived risk	634	175/349 (50.1)	157/285 (55.1)	0.81	0.60–1.12	0.74	0.52–1.07	0.67	0.46–1.01
More collective action	642	192/351 (54.7)	130/291 (44.6)	1.50	1.09–2.04	1.57	1.08–2.26	1.12	0.75–1.68

[a] Numbers vary due to missing data for some outcomes.
[b] Adjust for age group, village pair, SES, marriage, local residence, education level, current work/study status.
[c] Adjust for Model 2 plus presence of the IMAGE intervention.

levels of cognitive social capital (CSC) were largely HIV protective. These men felt more open to discuss sex in the home, reported more protective patterns of condom use, and HIV prevalence was reduced compared to their counterparts from households with lower levels of CSC. Household levels of structural social capital (SSC) played a less important role in this group.

The relationship between social capital and HIV risk were somewhat different for female household members. In this group, CSC and SSC were both associated with protective psychosocial attributes – including better communication, openness and participation in collective action. However, unlike in males, SSC seemed to also play an important role in shaping HIV risk. After adjusting for potential confounders, while young women with greater SSC reported more protective patterns of condom use, they conversely also had higher levels of both HIV prevalence and incidence.

The strengths of our analysis were that careful attention was given to the design and validation of measures of both cognitive and structural dimensions of social capital, the effects of potential confounders were addressed, numerous aspects of HIV risk were assessed, and biological measures of HIV incidence were used to capture recent infections. Nonetheless, this study also had a number of limitations that are important to draw attention to. Indicators used to assess social capital were derived from interviews with a non-random selection of poor households who participated in a microfinance intervention and a group of matched comparison households. While nearly half of households were eligible for participation based on poverty criteria, observed relationships may not adequately

reflect dynamics in the community as a whole. In addition, measures of social capital were derived from senior females, generating a proxy for household level dynamics. HIV risk was then assessed among a largely independent group of younger 'at-risk' household members. These measurement issues are very likely to account for observed gender differences in associations with SSC – where the social networks of senior females had more direct influence on observed associations in younger women than in men. While the research did endeavour to employ best practice techniques for assessing both cognitive and structural dimensions of social capital, our approach was rather novel and its appropriateness needs to be carefully weighed.

This study reaffirms findings from previous research in southern Africa suggesting social capital does have the potential to influence vulnerability to HIV (Campbell et al., 2002; Gregson et al., 2004; Nyanzi, Nyanzi, Wolff, & Whitworth, 2005; Poundstone et al., 2004). Our data suggest that strong community relations, characterized by a sense of mutual support, reciprocity, and collective mobilization around common concerns, are linked to lower levels of HIV risk among men and to a lesser extent among women. However, this work further emphasizes that not all social capital is protective or health promotive. Higher levels SSC, as reflected in expanded social group membership, may also have the capacity to exacerbate HIV risk in females. This is in line with the few other studies that have examined both SSC and CSC in developing countries where, contrary to expectations, high levels of SSC has been linked to *poorer* health outcomes, possibly as a consequence of overburdened social roles (De Silva & Harpham, 2007).

In our setting, that SSC may be associated with elevated HIV risk in young women suggests that expanding social networks on its own may serve to increase vulnerability to infection, particularly in the face of competing material needs and in an environment where the exchange of sex for resources is common (Dunkle et al., 2004). This resonates with research on geographic differences in HIV infection rates in sub-Saharan Africa where numerous sites document four- to six-fold variations in HIV prevalence within the same local area (Barongo et al., 1992; Bloom, Urassa, Isingo, Ng'washerni, & Boerma, 2002; Boerma, Urassa, Senkoro, Klokke, & Ng'weshemi, 1999; Killewo, Dahlgren, & Sandstrom, 1994; Kipp et al., 1995; Soderberg et al., 1994). This pattern highlights disparities between low prevalence isolated rural areas and higher prevalence more accessible trading centres – a difference that was also noted in our study site. Such gradients have been linked to enhanced opportunities for social and sexual networking that prevails along development corridors.

There are important implications of this work for HIV policy and practice in Africa. Working through new and existing social networks provides obvious venues for introducing innovations, shaping norms, and enhancing the design and delivery of prevention programs. However, getting the balance right may be central to their uptake and success. While creating new social networks alone may increase HIV risk in some settings (Nyanzi et al., 2005), careful attention to the content and quality of interactions within them may also have the net effect of facilitating HIV risk reduction.

This has been echoed in experience elsewhere. Within industrialized countries, the results of community intervention trials for HIV prevention that contain a component of social capital strengthening have been encouraging (CDC, 1999; Kelly, 1999; Kelly et al., 1997; Sikkema et al., 2005). Operating in high-risk environments such as gay bars and low-income housing developments, a number of innovative programs with well-designed evaluations have demonstrated success in reducing vulnerability to HIV by working through role models, opinion-leaders and established social networks to stimulate community awareness and mobilization around the disease. In many respects, these types of interventions attempt to stimulate the sort of social mobilization that has been linked to reductions in HIV prevalence as highlighted in the examples of Uganda and San Francisco cited above. Applying a social capital lens to community HIV prevention trials has the potential to illuminate whether and how interventions might facilitate effective social mobilization, and the interplay of cognitive and structural social capital in supporting these effects. In addition, better understanding the social processes associated with intervention uptake carries implications for program sustainability, replicability and transfer to other contexts. Operational research in this regard is at an early stage and further innovation is clearly required.

A social capital discourse may also deepen our understanding of risk environments – providing a theoretical bridge to link social contexts to their health consequences. While issues such as poverty, gender inequality or social exclusion might otherwise seem abstract and unapproachable, interventions at this level are increasingly recognized as an important yet underdeveloped component of the public health response to HIV/AIDS (Blankenship, Friedman, Dworkin, & Mantell, 2006; Parker et al., 2000; Sumartojo, Doll,

Holtgrave, Gayle, & Merson, 2000). Unlike working with individual behavior or biology, these 'structural interventions' are directed at place and populations (Hawe & Shiell, 2000; Lochner, Kawachi, & Kennedy, 1999) and have the potential to alter the 'context in which health is produced or reproduced' (Blankenship et al., 2006). Through shifts in laws, policies, institutional or environmental change, these interventions work to influence networks and norms in ways that generate more effective community responses to public health priorities, including HIV. Furthermore, interventions at the structural level often demand bringing diverse disciplinary perspectives to bear on the epidemic. Employing a social capital framework has the potential to facilitate a common conversation among representatives from these different disciplines, methodologies, and sectoral backgrounds (Woolcock, 2002).

In summary, we suggest that there remains much to learn about the relationship between social capital and HIV risk. While some suggest that the concept of social capital requires further scrutiny and has the potential to detract from important policy debates around social and economic inequality (Cattell, 2001; Fine, 2001; Navarro, 2004; Portes, 1998; Wakefield & Poland, 2005), others argue that deepening our understanding of social capital has the potential to provide useful insights into how communities work together to effectively respond to priority issues (Woolcock, 2002). We argue that the application of a social capital framework to the challenge of HIV in Africa provides insights into both vulnerability to the disease and the capacity to effectively respond to it. However, the results of this work also suggest a balanced and cautious application of social capital to HIV prevention is warranted, and that better understanding where and how to work with communities is essential for effective policy and program development.

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