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Can Burt's Theory of Structural Holes be applied to study social support among mid-age female sex workers? A multi-site egocentric network study in China

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Abstract

The epidemic of HIV/AIDS continues to spread among older adults and mid-age female sex workers (FSWs) over 35 years old. We used egocentric network data collected from three study sites in China to examine the applicability of Burt's Theory of Social Holes to study social support among mid-age FSWs. Using respondent-driven sampling, 1,245 eligible mid-age FSWs were interviewed. Network structural holes were measured by network constraint and effective size. Three types of social networks were identified: family networks, workplace networks, and non-FSW networks. A larger effective size was significantly associated with a higher level of social support [regression coefficient (β): 5.43–10.59] across the three study samples. In contrast, a greater constraint was significantly associated with a lower level of social support (β : -9.33 – -66.76). This study documents the applicability of the Theory of Structural Holes in studying network support among marginalized populations, such as FSWs.

Keywords

Theory of Structural Holes; Egocentric network; Social support; Mid-age female sex workers; China

INTRODUCTION

HIV/STIs among old population

Despite the preventive effects of antiretroviral treatment (ART) and a range of biomedical and behavioral interventions, only 38% of people living with HIV are virally suppressed and the HIV epidemic continues to spread among key populations, including female sex workers

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Compliance with Ethical Standards

Conflict of Interest:

The authors declare that they have no conflict of interest

Ethical approval:

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent:

Informed consent was obtained from all individual participants included in the study.

(FSWs) (1). Moreover, the epidemics of sexually transmitted infections (STIs), including HIV/AIDS, have spread into the older adult population over 50 years old in both developed and developing countries (2, 3), including China (4, 5). Commercial sex is a major transmission mode as many infected older adults reported a history of commercial sex with low-paying, mid-age FSWs over the age of 35 years old (6, 7). In contrast to studies using either national surveillance data or serial cross-sectional study data that reported a low prevalence of syphilis (between 2.4–7.2%) among predominantly young FSWs in China (8–10), the prevalence of syphilis was found to be much higher among mid-age FSWs (23.2%) in our previous report (11). While intervention programs have been implemented among young FSWs, few successful intervention programs have been implemented in this vulnerable population in China due to a lack of understanding of bio-psych-social factors facilitating the epidemics.

Sex work in China

Prostitution is illegal in China, but persists in both urban and rural areas (12). Sex work is scorned by the Chinese culture, forcing sex workers to face social adversity; including stigma, discrimination, vulnerability to violence, and a disparate burden of HIV/STIs (13). Sex work has been categorized into three levels (high, medium, and low) according to workplace, income, and client socioeconomic background (6, 14). High-level sex workers typically work in luxury hotels and provide commercial sex to high-income individuals such as wealthy businessmen. Mid-level sex workers usually work in dance halls, karaoke bars, massage parlors, and beauty salons. Their clients include private businessmen and other mid-income individuals. Low-level sex workers are usually older in their 30s and solicit commercial sex in roadside beauty salons or hotels, on streets, in parks, or at construction sites. Their clients include individuals with low income, e.g., labor workers, rural-to-urban migrants, or older adults. Low-level sex workers have a higher risk of acquiring or transmitting HIV/STIs than those at the high or middle levels (7, 10).

In contrast to young FSWs who usually start into sex work in their early 20's and quit sex work typically in their 30s (6), older FSWs enter into sex work in their late 30s after financial adversity, such as becoming unemployed, divorced, or migrating from rural to urban areas (6). Previous research in China and other developing countries has extensively examined risk factors for HIV/STIs and their psychosocial determinants (including social support) in young FSWs (15, 16). However, findings from these studies may not apply to older FSWs as they may engage in different risks for HIV/STIs, have different motivation to participate in preventive practices, or possess different psychosocial factors that determine their adoption or maintenance of behaviors.

Social network of female sex workers

Engagement in preventive practices (e.g., consistent condom use, testing for HIV/STIs, and adherence to treatment) is determined not only by personal factors, but by interpersonal factors or factors at the social network level. Social networks have been defined as individuals linked to a focal individual by a particular behavior or interaction (17). An individual egocentric network includes an index person (ego) and his/her network members (alters) (18). Social networks are conceptualized as comprising of three components:

relations, structures, and functions (19–21). Network relations refer to the type of network ties (e.g., kin, friends, coworkers, or sex partners). Network structures characterize the relationships between an ego and two or more his/her alters (e.g., network size, density, or structural holes) (22). Social support, one of the important network functions, influences network members' adoption or maintenance of behaviors (23–25). Social support can take a number of forms, including tangible and emotional support (21, 26). Tangible support is the provision of financial aid, material resources, and needed services (26). Emotional support is the expression of positive affect of one person toward another, the affirmation or endorsement of another person's ideas or behaviors (27, 28). The influence of social support on network members may stem from consensus, as well as from coercion, depending on the type and sources of social support and the characteristics of the relationship in which it occurs among network peers (22). Previous research has documented that these three network components are highly associated with health and risky behavior (22, 29). Positive influence from social networks can promote preventive behaviors (30, 31). When mid-age FSWs face risk for HIV/STIs, social support generated from their networks can empower them to decide to engage in health behaviors or safer-sex practices.

The social network approach for studying social support and its potential determinants is particularly useful in the Chinese collectivist culture. In comparison to the Western culture that individualism prevails, the Chinese collectivist culture is more likely to emphasize interdependence within the personal social network and harmony in social environments (32). Chinese people are encouraged to seek support or make decisions within the sphere of influence of their partners, peers, family members, or supervisors (33, 34). They place less emphasis on self-reliance and independence and more on a sense of obligation and responsibility to their networks (35). Social network research may provide new evidence regarding the constitution of mid-age FSWs' networks, interactions between egos and alters, and diffusion of social influences. The findings from our qualitative and quantitative studies in the same study population have documented that engagement in risk behavior for HIV infection was influenced by network factors and social support was positively associated with condom-protected sex (36, 37).

Because prostitution is illegal and FSWs face stigma related to sex work, they usually conceal their sex-work identity and selectively set up their social networks for seeking social support (37). Our previous qualitative study identified two types of networks: family networks (relationship with children, husbands, other family members) and workplace networks (relationships with peers, clients, pimps, and venue owners) (37). Although mid-age FSWs concealed their sex-worker identity from their family members, they received strong support from them. A low level of network support was observed between older FSWs and their clients, whereas positive social support was prevalent among older FSWs who had frequent contacts with peers. Their workplace network was denser and more closed compared with networks with peers who were not sex workers.

Highly dense networks indicate that alters are well-connected to each other, which could be viewed positively if ego is in need of social support (38, 39). However, evidence suggesting that denser social networks provide more network resources, such as social support, is mixed (28). High network density usually indicates more homogeneity in relationships and non-

diversified network resources, which may cripple a network in significant ways (40). First, when an ego's alters are connected to each other, the ego tends to receive similar types of network resources from alters. Second, dense networks may constrain egos from receiving adequate social support (38). In contrast, if an ego's alters are unconnected or dispersed in different social clusters, the ego may receive diverse types of social support from different clusters or subsets of alters. This network phenomenon has been described and explained by Burt's Theory of Structural Holes (40).

Burt's Theory of Structural Holes

Structural holes are the separations between non-redundant contacts or alters (41). Alters are redundant to the extent that they form clusters of alike individuals who provide similar network resources. Alters are non-redundant when they have no direct connection with one another (Figure 1: Ego A), creating a structural hole. Because the two alters are unconnected, network benefits to ego become more additive (e.g., covering two types of social support: emotional support and tangible support) than overlapping (e.g., covering one of the two types of social support). In the sparse or less dense network (Figure 1: Ego B), there are few connections or relations between alters (more non-redundant ties that lead to more structural holes). Thus, the sparse network usually provides egos with a larger volume of network benefits supplied from social clusters with diverse supporting resources. This network phenomenon is also called 'The Strength of Weak Ties' (42). In a dense network, there are strong relations between alters and each relation links the ego to the same people, leading to similar network resources (Figure 1: Ego C and D). The dense network is inefficient since it generates less diverse network resources (or benefits) than the sparse network does.

Following Burt's theory, redundant connections among alters may hinder mid-age FSWs from expanding their networks, limiting their subsequent access to external and different types of social support. In contrast, non-redundant alters of mid-age FSWs may expand opportunities to receive diverse resources from alters possessing different supporting resources. In the networks of mid-age FSWs, an ego or alter may bridge two different types of networks, for example, an alter may appear in the family network and workplace network or in the family network and network with peers who are not FSWs. According to this theory, older FSWs with well-structured networks (i.e., rich in structural holes) may obtain higher volumes and diversified types of social support (e.g., emotional support or tangible support).

Two indexes are commonly used to measure egos' structural holes (40): effective size and constraint. Effective size takes into account the redundancy of certain ties of alters. Some alters may duplicate the types of support they afford to the ego. Alters, who duplicate in this way, do not contribute to the effective size of ego's network. Network constraint measures ego's lack of access to structural holes. Constraint measures the extent to which an individual is restricted by her social network, and hence, the extent to which her social support becomes low. Less constraint of an ego indicates more structural holes in her egocentric network. Constraint is a combined measure of network size and density. Generally, constraint decreases when an ego has many alters (network size), and increases

when an ego has many closely connected alters (density) (Figure 1)(43). Despite several studies citing the benefits of using structural holes in the U.S. population, little empirical research has been conducted to test this theory outside of the U.S. We observed that few studies using Burt's theory were conducted among populations at risk for HIV/STIs. Shah and colleagues examined the association between structural bridging network position and HIV status in an epidemic of HIV among younger black men who have sex with men epidemic in Chicago, USA (44).

In this present paper, we address three main issues. First, we aim to describe and explore the structure of egocentric networks of mid-age FSWs. Second, we investigate the main factors that affect the amount of social support embedded in mid-age FSWs' egocentric networks. Third, we statistically test the following hypotheses that are conceptualized from Burt's Theory of Structural Holes:

Hypothesis 1: Network density is not associated with the level of social support received by mid-age FSWs.

Hypothesis 2: Effective size is positively associated with the level of social support.

Hypothesis 3: Constraint is negatively associated with the level of social support.

METHOD

The study methods have been previously described in detail (36, 45) The study protocol was approved by the Institutional Review Boards of the University of Maryland, Shandong University School of Public Health, and the Centers for Disease Control and Prevention in Hefei and Guangxi. Written informed consent was obtained from all participants.

Study subjects

An egocentric network study was conducted at three study sites in China: Qingdao (north), Hefei (central), and Nanning (south). The reasons for selecting these three sites included: (1) geographic coverage from northern to southern China; (2) variation in the number of HIV and STI cases; and (3) previous collaborations with researchers in these three cities. According to the local surveillance data and China National HIV/STD Surveillance (46), Nanning is located in the area with the highest HIV/STI prevalence (8,618 HIV cases and 36,404 notifiable STI cases reported from 2010 to 2013), Hefei with mid-level prevalence (1,105 HIV cases and 21,344 STI cases), and Qingdao with the lowest prevalence (733 HIV cases and 8,748 STI cases).

Participants were recruited into the study if: (1) they were female and lived in either of the three cities for at least three months; (2) were at least 35 years old, and (3) had exchanged sex for money at least once a week in the past month prior to the interview. Mid-age FSWs were defined as sex workers over 35 years old. The 35-year cut point was based on the findings from our previous qualitative studies conducted at the three study sites (6) and used by others (10, 47).

Recruitment of study subjects

Respondent-driven sampling (RDS) was used to recruit participants (48). Four or five seeds were selected from each site. The selection of seeds was based on the results from our qualitative study and suggestions from mid-age FSWs. All seeds received an explanation of the study purposes and procedures, as well as three coupons to recruit up to three eligible subjects. The number of recruitment waves was 8–11 at the three sites. Participants received compensation for their time and transportation costs, with \$10 given for their participation in the interview and \$3 for each eligible subject they recruited. Convergence plots and bottleneck plots were used to determine whether the final RDS estimates were biased by the initial convenience sample of seeds (49). Convergence was reached (e.g., the proportions of the five variables remained unchanged in the later recruitment waves) after 100–300 subjects were recruited at each site. Therefore, our evaluation of this RDS sample indicated success in reaching the convergence of RDS compositions and included a broad cross-section of the mid-age FSW population at each study site.

Interviews

Eligible subjects participated in a face-to-face anonymous interview in a private room. Interviewers used computer-assisted personal interviewing (CAPI) to interview subjects. Interviews were held at the clinics, hotels, and the local Centers for Disease Control and Prevention. These sites were chosen for their proximity to participants (less than 1 hour-travel time) and to ensure participant confidentiality.

Egocentric networks

The Chinese Social Network Questionnaire (CSNQ) was used to capture the social network of egos, which has been used and validated in our previous network studies (31, 50). Interview questions were drafted in English and then translated into Chinese by our team members who were fluent in both languages. Both qualitative (cognitive interviewing with 18 mid-age FSWs in Hefei) and quantitative techniques (pilot of the questionnaire among 60 mid-age FSWs in Nanning) were used to test the psychometric properties of the CAPI questionnaire. Measurement questions and scales were revised based on the findings from these pilots.

To delineate social networks, name-generating questions were used to ask respondents (egos) to list (either by first name or pseudonyms) alters who would provide them support. Alters could be friends, family members, relatives, pimps, venue owners, FSWs, or others whom the respondents knew for at least one month. Six items were used to define the egocentric network of an ego (51). Egos were asked to list alters who would: (1) lend the ego 200 Chinese dollars (\$30 US); (2) take care of the ego, if the ego were confined to bed for 2–3 weeks; (3) help or advise the ego if the ego had problems regarding family or health issues; (4) agree with or support the ego's ideas or actions; (5) make the ego feel respected or admired; or (6) convince the ego to confide in the alter. Ego's social networks comprised of all individuals who were perceived to provide at least one of the six types of social support to egos. Social demographic information about alters was collected from egos, including alters' age, education, marital status, and relation to egos.

Social support

The above six-item measure for social support covers tangible support (items 1–3) and emotional support (items 4–6). Four response categories were used to indicate whether an alter would provide support to the ego: (0) no support; (1) unsure if the alter would provide support; (2) possible support; and (3) alter would definitely provide support. We first summed the score of the six items from each alter in an ego's network and then multiplied the score by the number of alters to create a total score of social support at the ego level. A higher score indicates that an ego received a higher volume of social support from her network.

Statistical Analysis

Density refers to the proportion of ties in a network relative to the total number of possible ties. Respondents (egos) were given a matrix with the names of their network members (alters), and then were asked to indicate alters in their personal network who knew each other very well. Density is calculated as the total number of actual ties or connections divided by the total number of possible ties (38) and scores range between 0 and 1. Effective size for undirected binary data is ego's degree minus the average degree of alters (not including ties to ego). If there are no ties between alters then the average degree of alters is zero and, therefore, the effective size is ego's degree (Figure 1: Ego A). If all alters are connected to each other, then, the average degree of the alters will be one less than the degree of an ego, and thus the effective size would be one (Figure 1: Ego D). If an ego has no alters then she has an effective size of zero. Network constraint measures the extent to which ego's time and energy are concentrated on a single group of interconnected alters, limiting the ego's sources of support. We calculated how much constraint each alter has on ego. Ego constraint is the sum of these constraints (38). Its score ranges between 0–1.125. *UCINET* software (version 6.620) (52) was used to estimate the three indexes from each egocentric network of FSWs. Pearson correlation coefficients were estimated to assess correlations among network structure measures.

Three multiple linear regression models were created to test the three hypotheses. For each model the dependent variable was social support (sum of total support that an ego perceived from all alters) and the independent variable was either network density, effective size, or constraint, adjusting for factors at the ego level. Since both effective size and constraint are a function of not only ego's network density, but also of ego's network size, we did not adjust for network size to avoid multicollinearity (38). SAS version 9.4 (SAS Institute, Cary, NC) was used to conduct statistical analyses. Because of heterogeneity in the social demographic characteristics and network structures at the three study sites, separate analyses were performed by study site.

RESULTS

A total of 1,245 eligible older FSWs (egos) were recruited and interviewed (Nanning: 418; Hefei: 407; and Qingdao: 420). The median age was between 37–42 years old. The duration of sex work was longer in Qingdao (6.2 years) than Hefei (1.3 years) and Nanning (3 years). Between 35–48% of the egos received a primary education or less. The majority of egos

were married, widowed, or divorced. More than half of them were rural-to-urban migrants (between 59–74%) at the three sites (Table 1).

Egos named 5,858 alters (Nanning: 2,384; Hefei: 1,838; and Qingdao: 1,636). Approximately one-third of alters were at least 35 years old and received a middle-school education or above (Table 1). Most of them were single (between 66–80%). Their relation to the egos were FSW peers (19–38%), family members (13–29%), friends who were not FSWs (11–18%), clients (8–9%), husbands (6–8%), boyfriends (4–9%), other relatives (2–16%), and other relations (2–3%).

The average network size was 5.7 in Nanning, 4.5 in Hefei, and 3.9 in Qingdao. Egos in Qingdao perceived the lowest level of social support (39.9), compared with egos in Hefei (50.9) and Nanning (67.5). The network density was between 0.48–0.55, the effective size was between 2.2 and 3.5, and network constraints ranged between 0.49–0.60 at the three sites (Table 1). Across the three sites, social support was positively correlated with network size and effective size, but negatively correlated with network constraint (Table 2). Network constraint was negatively correlated with network size and effective size, but positively correlated with density. Effective size was positively correlated with network size, but negatively with density at all the three sites.

As documented in Table 3, the level of social support perceived by egos differed by their social demographics. FSWs who were more than 45 years old received the lowest level of social support compared to FSWs who were 45 years old or younger in Nanning, but perceived the highest levels of social support in Qingdao. Social support was not statistically associated with egos' age in Hefei. In general, older FSWs who had a longer duration of sex work and a higher level of education were more likely to receive a higher level of social support across the three sites. The level of social support was not significantly associated with egos' marital status and migrant status. Egos received a larger volume of social support from FSWs alters (a mean score of between 9.9–19.7), family member alters (6.3–14.6), and alters who were not FSWs (6.3–9.2), compared with social support received from husband alters (2.9–4.8), boyfriend alters (3.2–4.8), sex clients alters (3.1–4.3), bosses, pimps, or owners (0.8–1.8), and alters of other relations (0.6–1.3).

After adjusting for factors at the ego level, a larger effective size was significantly associated with a higher level of social support (β : 5.43–10.59) at the three study sites. In contrast, A greater level of constraint was significantly associated with a lower level of social support (β : -9.33 – -66.76). Density was significantly associated with a higher level of social support (β : 11.52) in Qingdao, but not in Nanning (β : 4.32) or Hefei (β : 3.73) (Table 4).

DISCUSSION

This study demonstrates the applicability of Burt's Theory of Structural Holes to study social support among mid-age FSWs in China. Our findings document that social network structural data can be obtained from ego networks rather than from sociometric networks which take much more time and resources to collect. The two structural holes indices were significantly associated with social support. That is, mid-age FSWs with structural holes

(larger effective size and smaller constraint) in their networks received higher levels of social support than those with more tightly knit networks. Also consistent with Burt's theory (41), larger networks increased access to structural holes by increasing effective size and decreasing constraints. In contrast, denser networks provided less access by decreasing the effective size and increasing constraints. These findings are robust as they are consistent across the three study sites. To our knowledge, it is the first study to investigate the applicability of the theory in FSWs, a special and vulnerable population for HIV/STIs. This study provides evidence that this theory can be applied to not only organizational networks, but also egocentric networks of marginalized populations, such as FSWs.

Similar to the findings from our qualitative study among mid-age FSWs (37), this quantitative study identified three types of social networks around mid-age FSWs: family network, workplace network, and non-FSW network. The family network consisted of alters with relations to egos, such as egos' family members, other relatives, and boyfriends. Three relations were identified in the workplace network: FSW peers, clients, and gatekeepers (pimps, venue owners, and bosses). In the non-FSW network, mid-age FSWs sought social support from peers who were not FSWs. Because these three networks belonged to different social clusters of alters, they may provide egos with different types of social support. The different social clusters create social holes which separate social support from each type (e.g., emotional or tangible support). Therefore, mid-age FSWs with structural holes in their networks were more likely to receive additive levels of social support (i.e., covering both emotional and tangible support from different social clusters) than overlapping (similar or one type of support from a dense network).

As depicted in Table 3, mid-age FSWs perceived to receive social support mainly from three groups of alters (accounting for 60–68% of the total support): FSW alters, family member alters (e.g., parents, sisters, or brothers), and non-FSW alters. A similar finding was reported among FSWs in Tijuana, in which FSWs selected to seek support from family members, female friends who were not FSWs, and other FSWs (53). Because of the nature of sex work, FSWs carefully select alters in their family networks and non-FSW networks in order to conceal their identity and avoid stigma and discrimination. In contrast, sex work-related stigma and discrimination do not occur among FSW peers, as they share the same identity and work in the same business. As a result, FSW peers constituted the majority of alters in the mid-age FSWs' social networks. Obviously, support provided by FSW alters differs from that provided by family members and non-FSW peers. Mid-age FSWs who carefully manage alters in the family networks and non-FSW networks can receive additional support that their FSW peers cannot provide. For example, the primary reason mid-age FSWs entered into the sex work was to make enough money to raise their children and support their families (6). FSW peers usually cannot provide egos with social support related to child education and family needs, but family members and non-FSW alters can. Similarly, family members and non-FSW peers cannot provide some support that FSW alters can, for example, support for safer sex or testing for HIV/STIs. Therefore, mid-age FSWs who manage to recruit these three types of alters in their networks can receive a larger volume of support and complementary social support from them in different social clusters. This is evidenced in Table 4, which shows that mid-age FSWs with a larger effective size perceived

a higher level of social support from alters, while those with a larger network constraint received a lower volume of social support across the three study populations.

In this study, the association between social support and network density was mixed. The association was positive and significant among mid-age FSWs in one site (Qingdao), but not at the other two sites. This relationship between density and support may be collectively determined by network size, effective size, and constraint because network density is a combined measure of the three structural measures within egocentric networks. Due to the co-existence of density and constraint in an egocentric network, it is possible that the degree of the positive association between support and density is counterbalanced by the degree of negative association between support and constraint. We verified this possibility by entering both density and constraint into the same regression model. The results indicated that the constraint-adjusted association between support and density became larger and reached the significant level ($p < 0.01$) across the three study samples. Compared to the other two sites, mid-FSWs in Qingdao had smaller network size, smaller effective size, lower support, but a larger network density and constraint. This difference may make the association between support and density greater and significant at the Qingdao site.

The level of social support received from husbands, boyfriends, sex clients, and gatekeepers (pimps, bosses, and venue owners) was low in the three study populations. About half of mid-age FSWs were married. However, less than 10% of the alters listed were their husbands providing support, reflecting their difficult and vulnerable situation. For example, on the one hand, they took risks to make money to support their families, and on the other hand, they could not obtain support from their husbands. In addition, between 29–59% of mid-age FSWs were widowed or divorced and had to seek social support from other alters, for example, immediate family members or peers who were not FSWs. A similar finding was reported among FSWs in China (54) and in Tijuana (53). Relationships between mid-age FSWs and their clients are typically a one-time business transaction, and therefore, FSWs seldom seek social support from them. Consequently, perceived social support from clients was low. This result is supported by other studies indicating non-sexual relationships with FSWs are a key source of social support (55, 56). Gatekeepers and mid-age FSWs maintained a reciprocal beneficial business relationship. Gatekeepers are responsible for recruiting clients for FSWs, and FSWs paid a fee to gatekeepers for each sex transition. Because of this relation, mid-age FSWs usually did not seek social support from them beyond sex transactions. Low support from gatekeepers has been reported among mid-age FSWs from our qualitative study (6) and others (47, 57).

The contributions of this study should be considered in the light of its limitations. First, the cross-sectional nature of the survey did not allow us to identify causal relationships because of potential temporal ambiguity bias. Similarly, this study did not consider the long-term role of structural holes on social support as they were measured cross-sectionally. Research has suggested that network structures and their roles changes over time (58). Second, the results may not be generalizable to the broader population of mid-age FSWs and their alters as it was conducted only in three areas in China. Third, structural holes and social support were measured by self-report, which could be inaccurate due to recall bias or social desirability bias.

We propose two directions of future social network research according to the findings from this study. First, the causal associations between structural holes and network support need to be verified in longitudinal research in different study populations, for example, drug users, men who have sex with men, and rural-to-urban migrants. Because effective size and constraint may be related to the instability of social networks, the dynamic patterns of the structural holes and their causal relationships with social support and engagement in HIV risk behavior need to be investigated over time, using innovative social network methodology. The second research direction is the translation of the research findings into interventions. Both the treatment-as-prevention (TasP) and pre-exposure prophylaxis (PrEP) intervention approaches have significant effects on the prevention of HIV transmission. However, the key to the success of the two intervention strategies is adequate adherence to treatment and PrEP. Because the life-long use of anti-viral drugs requires sufficient support from social network and environment (policy support and medical service) (59), the social network factors embedded in the environments of users may either facilitate and/or impeded adherence. HIV/AIDS interventions need to address the three types of social networks around mid-age FSWs, the structures of networks, redundant and non-redundant connections, and their environmental resources. In particular, interventions need to take the feature of structural holes into consideration as they play an important role in facilitating the flow and diffusion of intervention information and other resources within or across social networks and influence network members' adoption or maintenance of behaviors.

In summary, the study makes an important contribution to Burt's Theory of Structural Holes and provides empirical evidence that this theory can be used to study social support among mid-age FSWs. The depiction of social network relations and structures facilitates our understanding of the impact of composition and structure of egocentric networks on social support. The findings document that network composition and structure play different, yet complementary, roles in seeking social support in this key risky population for HIV/STIs. The role of structural holes on social support suggests that interventions that target social support to motivate preventive behavior or practices should consider addressing network structural holes first.

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Figure 1.
Illustration of structural holes in 4 egocentric networks

Table 1

Characteristics of egos and alters at three study sites

	Nanning	Hefei	Qingdao
Ego characteristics	n = 418	n = 407	n = 420
Age (years) *	37 (36–40)	38 (35–43)	42 (36–48)
Duration of sex work (years) *	3.0 (1.8–5.0)	1.3 (0.5–3.0)	6.2 (4.0–9.9)
Education			
Primary or less	151 (34.5)	202 (47.9)	193 (43.0)
Middle school	213 (52.3)	171 (42.2)	193 (46.5)
High school	54 (13.3)	34 (9.9)	34 (10.4)
Marital status			
Unmarried	52 (13.3)	47 (13.1)	17 (2.5)
Married	237 (57.6)	226 (54.5)	147 (38.6)
Widow/divorced	129 (29.2)	134 (32.4)	256 (58.9)
Migrant			
Yes	315 (73.8)	245 (58.9)	305 (66.4)
No	103 (27.2)	162 (41.1)	115 (33.6)
Alter characteristics	n = 2384	n = 1838	n = 1636
Age (years)			
<35	485 (20.5)	452 (24.8)	204 (12.5)
35	1878 (79.5)	1373 (75.2)	1422 (87.5)
Education			
No or primary school	711 (29.8)	521 (28.4)	356 (21.8)
Middle school	987 (41.4)	716 (38.9)	602 (36.8)
High school or above	498 (20.9)	462 (25.1)	454 (27.7)
Unknown	188 (7.9)	139 (7.6)	224 (13.7)
Marital status			
Single	1909 (80.1)	1385 (75.3)	1077 (65.8)
Married	243 (10.2)	230 (12.5)	418 (25.5)
Widow/divorced	221 (9.3)	192 (10.5)	129 (7.9)
Unknown	11 (0.5)	31 (1.7)	12 (0.7)
Relation to ego			
Husband	165 (6.9)	147 (8.0)	105 (6.4)
Boyfriends	101 (4.2)	165 (9.0)	116 (7.1)
Clients	190 (8.0)	168 (9.1)	147 (9.0)
Non-FSW peers	255 (10.7)	325 (17.7)	281 (17.2)
FSW peers	777 (32.6)	354 (19.3)	621 (38.0)
Boss, pimps, or owners	44 (1.8)	67 (3.6)	92 (5.6)
Family members	421 (17.6)	523 (28.5)	212 (13.0)
Relatives	383 (16.1)	30 (1.6)	25 (1.5)
Others relations	48 (2.01)	59 (3.2)	37 (2.3)
Network structure**			

	Nanning	Hefei	Qingdao
Size	5.7 (2.6)	4.5 (2.3)	3.8 (1.7)
Density	0.5 (0.30)	0.5 (0.37)	0.6 (0.35)
Effective size	3.5 (1.97)	2.7 (1.73)	2.2(1.30)
Constraint	0.5 (0.23)	0.6 (0.27)	0.6 (0.26)
Social support	67.5 (35.51)	50.9 (26.03)	39.9 (21.92)

*
median and quartile

**
mean and standard deviation

Table 2

Correlations among network size, density, effective size and constraint

	Social support	Size	Density	Effective size
Nanning				
Size	0.90 *			
Density	0.03	−0.07		
Effective size	0.60 *	0.78 *	−0.54 *	
Constraint	−0.43 *	−0.51 *	0.73 *	−0.64 *
Hefei				
Size	0.87 *			
Density	0.03	0.01		
Effective size	0.61 *	0.72 *	−0.54 *	
Constraint	−0.38 *	−0.43 *	0.78 *	−0.62 *
Qingdao				
Size	0.70 *			
Density	0.17 *	0.15 *		
Effective size	0.32 *	0.66 *	−0.48 *	
Constraint	−0.11 **	−0.14 *	0.80 *	−0.42 *

*
p< 0.01;**
p<0.05

Table 3

Level of social support perceived by egos with different characteristics

	Nanning	Hefei	Qingdao
	Mean (SD)	Mean (SD)	Mean (SD)
Age (years)			
<35	59.4 (40.8) *	55.6 (24.4)	43.7 (23.7) **
35–44	69.2 (35.5)	50.7 (25.5)	35.0 (18.7)
45 and older	55.9 (30.7)	46.8 (28.6)	45.6 (24.0)
Duration of sex work (years)			
≤ 1	59.2 (33.2) *	46.6 (25.9) *	28.1 (22.1) **
2–3	66.7 (33.7)	52.8 (25.2)	35.0 (19.6)
4–5	74.4 (38.0)	57.7 (26.5)	38.9 (22.3)
>5	65.4 (34.9)	53.1 (26.4)	42.8 (21.9)
Education			
Primary or less	60.6 (33.8) **	48.9 (27.1)	37.3 (20.6) *
Middle school	72.2 (36.1)	52.2 (25.5)	41.2 (22.4)
High school	68.3 (35.3)	56.9(20.8)	47.2 (24.6)
Marital status			
Unmarried	63.1 (28.1)	54.3 (28.2)	31.8 (13.1)
Married	69.5 (36.0)	49.6 (24.5)	42.3 (22.1)
Widow/divorced	65.7 (37.2)	52.2 (27.7)	39.0 (22.2)
Migrant			
Yes	68.7 (36.6)	52.7 (26.7)	38.8 (21.4)
No	63.8 (31.6)	48.4 (24.8)	42.7 (23.0)
Received support from alters			
FSW alters	19.7 (16.4) *	9.9 (13.7) *	14.7 (16.6) *
Family member alters	13.5 (19.8)	14.6 (16.8)	6.3 (9.9)
Non-FSW alters	7.6 (13.3)	9.2 (13.5)	6.3 (10.5)
Husband alters	4.8 (6.4)	4.4 (6.2)	2.9 (5.2)
Boyfriend alters	3.2 (6.2)	4.8 (7.6)	3.6 (6.9)
Client alters	4.3 (7.5)	4.0 (8.5)	3.1 (6.1)
Boss, pimps, or owner alters	0.8 (2.6)	1.8 (4.5)	1.5 (3.5)
Relative alters	12.4 (20.0)	0.9 (3.4)	0.9 (4.1)
Others relations	1.2 (5.2)	1.3 (4.2)	0.6 (2.9)
From all alters	67.5 (35.5)	50.9 (26.0)	39.9 (21.9)

*
p<0.05;**
p<0.01

Table 4

Associations between social support and network structures

	Nanning		Hefei		Qingdao	
	β^*	p value	β	p value	β	p value
Ego density	4.32	0.46	3.73	0.290	11.52	<0.01
Effective size	10.59	<0.01	9.11	<0.01	5.43	<0.01
Constraint	-66.76	<0.01	-35.34	<0.01	-9.33	0.020

* Regression coefficient

Adjusted for factors at the ego level: age, duration of sex work, education, marital status, and migrant