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NETWORK STRUCTURE, MULTIPLEXITY, AND EVOLUTION AS INFLUENCES ON COMMUNITY-BASED PARTICIPATORY INTERVENTIONS

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Abstract

This study applies an ecological perspective to the context of community-based participatory research (CBPR). Specifically, it examines how endogenous and exogenous factors influence the dynamics of CBPR partnerships, including the tendency toward reciprocity and transitivity, the organizational type, the level of resource sufficiency, the level of organizational influence, and the perceived CBPR effect on organizations. The results demonstrate that network structure is related to the selection and retention of interorganizational networks over time, and organizations of the same type are more likely to form partnerships with each other. It shows that the dynamics of the CBPR initiative presented in this article were driven by the structure of the interorganizational networks rather than their individual organizational attributes. Implications for sustaining CBPR partnerships are drawn from the findings.

Community-based participatory research (CBPR) is defined as "a collaborative approach to research that democratically involves community participants and researchers in one or more phases of the research process" (Nation, Bess, Voight, Perkins & Juarez, 2011, p. 90). In public health, there is a growing recognition that CBPR is a promising approach to bridge the enduring divide between scientific research and community effect, thus facilitating the translation of research findings into changes in practice and policy (Gonzalez et al., 2011; Valente, Fujimoto, Palmer, & Tanjasiri, 2010; Horowitz, Robinson, & Seifer, 2009; Rasmus, 2014). CBPR encourages collaborative and equitable involvement of all partners in all the phases of research and integrates knowledge sharing and intervention to achieve mutual benefits. The partnerships reflect the growing interdependence between community-based organizations and research institutes.

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Studies have highlighted the importance of analyzing dynamics in community health research (Lounsbury & Mitchell, 2009; Goldman, Morrissey, & Ridgely, 1994; Morrissey, Johnsen, & Calloway, 1997). Examining the structure of CBPR partnerships over time contributes to understanding how collaborative organizations build and sustain community capacity to improve health outcomes, such as reducing health disparity and improving greater access to health services (Valente, 2010, 2015; Luque et al., 2011; Rosenheck et al. 1998). In addition, studies have demonstrated asymmetric power relations among CBPR partners, which pose challenges to the sustainability of the interorganizational coalitions (Dworski-Riggs & Langhout, 2010; Umemoto et al., 2009).

Recent literature has suggested the use of social network analysis to evaluate CBPR partnerships and provide insights on community coalition building, because network theories, tools, and models are suited for analyzing coalition formation and dynamics of interorganizational relationships (Luque et al., 2010, 2011; Provan et al., 2003; Gold et al., 2008; Valente, 2010; Neal & Christens, 2014). Social network analysis also allows the evaluation of overall CBPR effectiveness systematically (Morrissey et al., 1997; Morrissey et al., 2002; Valente, 2010; Valente et al., 2015).

Guided by a multitheoretical, multilevel (MTML) analytic framework (Monge & Contractor, 2003), this study applies community ecological theories and network theories to examine the patterns and dynamics of interorganizational networks in a CBPR initiative, where different types of organizations form partnerships in overlapping resource niches (Aldrich & Ruef, 2006). An examination of the structure of these networks is essential to understanding what internal and external forces drive the CBPR partnerships over time.

This study makes two contributions to the study of interorganizational networks. First, it provides an empirical investigation of how evolutionary theories can be applied to explain the dynamics of CBPR partnerships. This study views all the organizations involved in a CBPR initiative as an organizational community where different types of organizations compete for resources and collaborate for collective goals, and analyzes how the coalition within and between organizational populations changes over time. Second, through the analysis, this study demonstrates how network structure and organizational attributes play different roles in influencing the dynamics of CBPR partnerships. It shows that both transitive network structures and the network attachment logic of homophily play an important role in the selection and retention of CBPR partnerships over time. Implications on how to build and sustain CBPR partnerships are drawn from the findings.

AN ECOLOGICAL MODEL OF COMMUNITY-BASED PARTICIPATORY RESEARCH

A community ecological approach has been applied to analyze interorganizational ties, which emphasizes the relational aspect of organizational populations (Monge, Heiss, & Margolin, 2008; Powell, White, Koput, & Owen-Smith, 2005; Lee & Monge, 2011). This is consistent with Hawley's (1950) argument on human ecology that attention should be paid to the broader area of organizational communities. An organizational community is defined as "a set of co-evolving organizational populations joined by ties of commensalism and

symbiosis through their orientation to a common technology, normative order, or legal-regulatory regime" (Aldrich & Ruef, 2006, p. 243). An organizational population is defined by types of resources that its member organizations value for survival. Organizational populations involved in one organizational community interact with each other based on their common resource space, which is defined as the overlapping niches that contain the resources to sustain each population (Hawley, 1986; Monge et al., 2008).

A full understanding of the dynamics of an interorganizational coalition requires the examination of both organizations and their networks. Traditionally in the literature of interorganizational coalition, much attention has been paid to how organizational properties affect their collaborative actions. Community ecology theories shift the focus of analysis from a single organizational population to populations of organizations, thus viewing how environmental resource niches at organizational, population, and community levels affect dynamic transformations in the organizational community (Monge et al., 2008).

A CBPR initiative can be considered an organizational community, where there are at least two different populations of organizations involved: (a) community-based organizations (CBOs), which are nonprofit entities operating within and serving a local community, and (b) academic institutes that are focused on research. Applying the community ecological perspective, the linkages between any CBOs or relationships between any academic institutes can be analyzed under the framework of commensalism, which refers to the relations between similar units in terms of the competition and cooperation. In addition, the cross-sector relationships between CBOs and academic institutions can be examined from the perspective of symbiosis, which refers to mutual interdependence between dissimilar units.

CBPR programs are essentially ecological because they aim to build long-lasting collaboration among partners, which drives the dynamics of the interorganizational networks through processes of variation, selection, and retention (Campbell, 1965). Variation of CBPR partnerships refers to changes in network ties (Aldrich & Ruef, 2006; Shumate, 2012). In the CBPR organizational community, the variation of organizational network ties can be intentional, driven by forces such as formal programs designed to promote the CBPR initiatives or direct incentives offered to organizations (Aldrich & Ruef, 2006). For example, Minkler, Blackwell, Thompson, and Tamir (2003) show that in the United States, the support from government and private interests have been a major force in advocating and funding CBPR, thus promoting a deeper sense of cross-sector collaboration. The variation can also be unintentional, driven by unexpected or unforeseen events such as job turnover within CBPR collaborating organizations.

Selection is the process of choosing one alternate variation over others (Campbell, 1965). In CBPR partnerships, it is about the choice to network with one particular organization for certain purposes, such as to get informed interpretation of research findings that provide evidence for local policymaking (O'Brien & Whittaker, 2011). Selection criteria can be set within or outside an organization. On the one hand, external selection is driven by forces like government intervention in labor markets, competitive pressures, growing pressure from unions, and so on (Baron et al., 1986; Baron et al., 1988). The external force may also

originate from conformity to institutionalized norms. On the other hand, selection can also occur from internal organizational structuring. For example, the tendency toward stability may explain why organizations tend to select previous partners whom they trust to work with. Another example is the homogeneity principle, indicating that the same types of organizations tend to work together given that they share similar operating systems.

Last, retention refers to the ongoing process of organizations reaffirming selected variations and reenacting them over time (Campbell, 1965). The retention of network ties could help maintain the sustainability of partnerships in the CBPR organization community. Consistent with the rationale of external and internal selection forces, retention can occur at both levels when selected routines are preserved, duplicated, or reproduced (Aldrich & Ruef, 2006).

Applying the ecological perspective to CBPR studies is not new. The community psychology literature suggests that the ecological perspective emphasizes the importance of understanding dynamics of CBPR partnerships, which is critical to archiving common goals such as developing sustainable and cohesive communities and successfully implementing intervention to lead to positive behavior change (Rappaport, 1987; Neal & Christens, 2014; Jason, Light, Stevens, & Beers, 2014). However, the community ecological perspective differs from other ecological perspectives through the combination of both ecological and network perspectives and, thus, is able to capture the dynamics of CBPR partnerships at multiple levels.

A great deal of literature has been devoted to uncovering factors that influence the patterns and dynamics of interorganizational networks (Morrissey et al., 1997; Luque et al., 2010). However, too much emphasis has been placed on the effect of organizational attributes (e.g., organizational mission, size), which act as internal forces for selecting partners (Monge & Contractor, 2003; Cardazone, Sy, Chik, & Corlew, 2014). The role of network structure has been underinvestigated, with some notable exceptions in the fields of sociology, public health, and community psychology (such as Provan et al., 2003, 2004, 2005; Powell et al., 2005; Luque et al., 2011; Galaskiewicz et al., 1979, 1985). Applying the community ecological perspective helps us analyze whether the dynamics of CBPR partnerships are driven by resources and/or existing networks, thus providing implications of how to achieve sustainable partnerships and mutual growth among collaborative organizations (Andrews, Cox, Newman, & Meadows, 2011; Aldrich & Ruef, 2006).

The MTML approach suggests that both endogenous and exogenous mechanisms should be analyzed in understanding network evolution (Monge & Contractor, 2003). Endogenous variables are defined as “relational properties inherent in the focal network that influence the realization of that network” (p. 55). Endogenous mechanisms suggest that networks are governed by their internal structural logic such as reciprocity (i.e., the proportion of mutual ties in a network) and transitivity (i.e., the proportion of transitive triads in a network). Exogenous variables are “various properties outside the focal network that influence the probability of ties being present or absent in the focal network” (p. 55). Exogenous mechanisms imply the influence of external variables such as other types of networks and nodal attributes.

Guided by the MTML framework, the current study examines endogenous tie structures of CBPR partnerships and exogenous nodal attributes. In the next section, previous studies on interorganizational networks were drawn upon to propose hypotheses regarding endogenous and exogenous mechanisms to model network structuring processes in the CBPR organizational community.

ENDOGENOUS TIE STRUCTURE: RECIPROCITY, TRANSITIVITY, AND MULTIPLEXITY

In the interorganizational field, evidence has been found that organizations tend to form reciprocal ties with each other to increase levels of joint actions and reduce dependence asymmetry (Das & Teng, 2000). It is through joint dependence that partner organizations form higher trust (Gulati & Sytch, 2007). Recent studies also confirm that the reciprocity persists over time (Shumate, 2012; Zeng & Chen, 2003). In the CBPR community, certain coalition activities require the establishment of reciprocity with community partners, such as information sharing, client referral, communication for outreach, and event coparticipation (Palmer-Wackerly, Krok, Dailey, Kight, & Krieger, 2014; Provan et al., 2004; Fujimoto, Valente, & Pentz, 2009; McKinney, Morrissey, & Kaluzny, 1993). Given that CBPR focuses on achieving mutual benefits for all partners, the following hypothesis (H1) is proposed: The CBPR partnerships will have a tendency toward reciprocity.

Another factor that might influence the choice of partners is the existence of common partners, which refers to the closure of transitive ties. Hicks et al. (2012) have described how trust influences the perception of benefits that partner organizations can provide and, thus, the effectiveness of CBPR partnerships. Partners of partners tend to have a good network reputation. Transitivity tends to emerge because organizations can find clues about potential partners from their existing partners with less cost and risk. Previous studies found that organizations tend to establish direct ties with a partner's partners (Atouba & Shumate, 2010; Lee & Monge, 2011). This type of connection may generate a chain of three organizations forming transitive ties. Therefore, the following hypothesis (H2) is proposed: The CBPR partnerships will have a tendency toward transitivity.

Recent literature on interorganizational networks from the community ecological perspective has highlighted the importance of multiplexity, which denotes the strength of the relationship between partners or the number and types of ties that are maintained by pairs of partner organizations (Provan et al., 2005). Multiplexity in CBPR partnerships has been investigated. Manning and others (2013) argue that the growth of multiplexity indicates sustainability of partnerships. Other studies have documented evidence of increasing densities of multiplexity and trust among partners (Provan et al., 2004; Luque et al., 2011). Valente et al. (2010) have examined multiple CBPR-related networking activities including communication, formal agreement, client referral, training, research, education, and outreach and advocacy. What remains uncovered is how the change of one networking activity is trigger by the change of other activities in the CBPR context.

In analyzing the sustainability of interorganizational partnerships, one key finding on multiplexity is that communication networks are important in influencing the coevolution of

interorganizational networks (Lee & Monge, 2011). In an organizational community, the existence of ties in the communication network will increase the likelihood of tie formation among the same pair of organizations in another network type. However, what other networking activities influence the dynamics of interorganizational collaboration is still underinvestigated. Furthermore, the network activity at earlier times will also affect the network activities at later times (McKinney et al., 1993). Therefore, this study examines the following research question (RQ1): What networking activities are coevolving to sustain the CBPR partnerships?

EXOGENOUS INFLUENCE: HOMOPHILY AND RESOURCE DEPENDENCE

This section focuses on the exogenous mechanisms that are the effects of organizational attributes on the sustainability of interorganizational networks. One organizational attribute is the organizational type, which is usually measured by its organizational population (Lee & Monge, 2011). As discussed earlier, there are at least two organizational populations in a typical CBPR initiative: academic institutes and community-based organizations. Strong evidence shows that same types of organizations tend to collaborate with each other, as summarized in the saying “birds of feathers flock together” (McPherson et al., 2001; Monge & Contractor, 2003). Specifically, we are interested in analyzing whether the network logic of homophily applies to the CBPR community. This study examines whether homophily exists in CBPR partnerships. Therefore, in the CBPR organizational community, organizations of the same type will be more likely to collaborate with each other (H3a).

Another organizational attribute that might influence the selection of network partners over time is the level of resource sufficiency (Atouba & Shumate, 2010; Cardazone et al., 2014; Evans et al., 2014). The argument is well elaborated in the theory of resource dependence, which focuses on strategic actions organizations undertake to manage their interdependencies with other organizations in the environment to enhance their autonomy and pursue interests (Pfeffer & Salancik, 1978; Aldrich & Ruef, 2006; McKinney et al., 1993). The patterned flow of resources and their distribution shape interorganizational tie formation (Lee & Monge, 2011).

The ability to secure human, financial, and other resources is considered crucial for all the organizations to engage in the development of CBPR (Metzler et al., 2003; Minkler et al., 2003). Organizational cooperation is purposeful and resource-dependent in the nonprofit sectors (Steffek, 2012). Small nonprofit organizations with limited resources tend to be the least central ones in the CBPR collaboration network (Luque et al., 2010). Therefore, organizations that are resource sufficient will be more likely to be chosen as partners by other organizations. Therefore, in the CBPR organizational community, organizations will be more likely to collaborate with organizations that are more sufficient in resources (H3b).

Another organizational attribute that might influence the selection of partners is the level of organizational influence (Shumate & Lipp, 2008). Organizational influence indicates the degree of power one organization holds in an organizational community. In the context of CBPR, the influence could be exerted on different stakeholder groups including policy makers, health service agencies, and media, among others. The mechanism of preferential

attachment indicates the rich get richer (Barabási, 2002; Powell et al., 2005; Evans et al., 2014). Organizations that are engaged in CBPR will prefer collaborating with other organizations that are more influential. Therefore, in the CBPR organizational community, organizations will be more likely to collaborate with organizations that are more influential (H3c).

The principle of CBPR initiative is to promote translational research by balancing the desire for research interventions and the desire to understand the effect on local communities (Metzler et al., 2003). This requires the cross-sector collaboration between nonresearch and research institutions throughout the process of research planning, implementation, evaluation, and dissemination of findings (Valente et al., 2010; Israel, Eng, Schulz, & Parker, 2005). Organizations that perceive a greater effect of CBPR partnerships will be more likely to collaborate with other organizations. Therefore, in the CBPR organizational community, organizations will be more likely to collaborate with organizations that perceive more CBPR collaboration effect (H3d).

METHOD

Data

The study analyzes two waves of network data, which were collected from organizations that were involved in the Weaving an Islander Network for Cancer Awareness Research and Training (WINCART) initiative. WINCART is a community–academic collaborative to reduce cancer health disparities among Native Hawaiian/Pacific Islanders, who are considered a high-risk population for cancer according to U.S. Department of Health and Human Services (Tanjasiri et al., 2007).

The first wave of the survey was disseminated to 121 individuals working in 19 organizations in June 2005, and 91 respondents completed the survey, with a response rate of 75.2%. The second wave was distributed to 135 individuals in 24 organizations in February 2010, and 97 respondents completed the survey, with the response rate of 71.85%. The individuals who received the survey invitation were identified through the following procedure: Members from all the WINCART partner organizations nominated the names of up to 10 potential survey respondents, who were directly involved with WINCART activities, who might be involved in WINCART future events, or who might be important for developing the organization’s commitment to WINCART (Tanjasiri et al., 2007).

At both time points, self-reported data were derived from four network questions that were asked via a roster format that contained a list of organizations affiliated with WINCART. The four types of networks were about communication, formal agreements, referring clients, and receiving client referrals. To examine the network evolution, only 16 organizations that were present at both time periods were included in the analysis. The four networks were recorded as directional over the two time points, to indicate the initiative of each organization in forming partnerships with others.

Measurement

The attributes of all these organizations were recorded. The organizational type was coded into two categories: academic and community-based organizations. Organizations were coded as community-based organizations when their main goal was to serve local communities, while organizations were coded as academic when their main goal was on education and research.

The level of resource sufficiency was measured at three levels: financial resource, human resources, and physical resources. The measure ranged from 1 (not at all sufficient) to 5 (very sufficient). A composite variable was conducted by taking the average of these three measurements.

Organizational influence was measured by asking respondents how much influence they think their organization or institution has on different social groups, including government leaders, business leaders, public health officials, hospitals and other health service agencies, media, parents or parent group, cultural or religious leaders, and academic researchers and on how Pacific Islander health and cancer data are collected and reported. The answers ranged from 1 (no influence at all) to 5 (a lot of influence). Factor analyses were conducted to check the internal consistency of the scales used to measure these attribute variables. All the scales had Cronbach's alphas above .75.

The perceived CBPR impact was measured by asking respondents how they perceived the effect of the WINCART collaboration on their organization. They were asked to respond to the following statements: "In the past year, how much has your general organizational or communication skills (such as public speaking or program planning) changed?"; "How much have your skills in presenting your views on community needs before a group changed?"; "How much have your skills in designing and carrying out prevention programs, specifically regarding cancer, changed?"; and "How much has your knowledge about community services, events and resources for cancer prevention changed?" The answers ranged from 0 (not applicable) to 5 (major change).

Analysis

All the data were aggregated to the organizational level. For the network ties, because the number of respondents from each organization varied, the number of links between organizations was summed and then divided by the number of respondents from each organization. The network data were dichotomized with the mean connection percentage across all four networks from the two time waves. Organizational attributes were constructed by taking the average of the individual responses from each organization.

To test the hypotheses, this study applied a stochastic actor-oriented model, which estimates network evolution parameters with simulated network processes. Specifically, the SIENA within the R project package (version 1.1–232) was used to conduct the analysis of network data and attributes data over the two time points (Ripley, Snijders, Boda, Voros, & Preciado, 2014).

We examined all hypotheses by examining two factors in the SIENA model: (a) good convergence of the model, indicated by the t-ratios less than 0.1, and (b) the significance of parameter estimates, indicated by being at least 1.96 times the magnitude of the standard error. The analysis was conducted in the following order. First, we examined the models with all the hypothesized parameters on communication networks. The baseline model was constructed with standard network structures (including rate parameter and density), relevant network structures to the hypotheses (reciprocity and transitivity), and one organizational attribute (organizational type). The second model was constructed by adding organizational influence to the baseline model and the third model by adding CBPR impact to the baseline model. Second, the same procedure was followed to examine the formal agreement networks, receiving clients networks, and referring clients networks.

To examine the research question regarding the multiplexity, quadratic assignment procedure tests were run among the eight networks. An exploratory approached was applied to include all the correlation scores to run structural equation modeling (SEM), which helped identify what CBPR networking activities significantly predicted other networks. SEM was ran in R and the path diagrams were generated using LISREL 8.80. We first tested a theoretical SEM model, hypothesized based on the community ecology theory. The model was tested using the following procedures. First, the overall goodness of fit tests were conducted at the global level, assessed with an insignificant chi-square. Second, at the local level, the statistical significant of each path was assessed based on t values. At the 0.05 alpha level, the critical value of t is 1.96, and at the 0.01 alpha level, the critical value is 2.58. Third, we modified the model by deleting all the insignificant paths from the hypothesized model and adding suggested paths from the modification indices, which constructed the final model (Byrne, 1998).

RESULTS

Descriptive statistics are summarized in Table 1 and network descriptive statistics are summarized in Table 2. Over time, the density of communication network, formal agreement network, and referring clients network increased, while the density of receiving clients network decreased. Reciprocity decreased for all the networks except communication. The indegree centralization increased for all the networks except for the formal agreement network. The outdegree centralization increased for all the networks except the communication one. In addition, Table 3 provides the Jaccard index, measuring network turnover from Time 1 to Time 2. Jaccard index is a measurement for stability, whose value should be close to .20, to have enough power to estimate RSiena parameters (Ripley et al., 2014).

The baseline model of communication network included rate parameter, density, reciprocity, transitivity, and organizational type. To test the hypotheses, further parameters were added one by one. Model 1 had the level of resource sufficiency added. The model had a good convergence. H1 stated that over time the CBPR partnership will have a structural tendency toward reciprocity. This hypothesis was not supported in Model 1 (estimate = .62, standard error [*SE*] = .89). H2 predicted that the partnership would have a structural tendency toward transitivity, which was supported (estimate .13, *SE* = .06). H3a stated the homophily effect

from the organizational type, which was supported (estimate = .79, *SE* = .30). H3b stated the effect of resource sufficiency on time formation probability. It was not supported (estimate =.31, *SE* =.69).

To test the effect of other organizational attributes, and in particular H3c and H3d, two more organizational attributes were added onto the baseline model separately: organizational influence (Model 2) and CBPR impact (Model 3). Neither H3c nor H3d was supported. As we can see from Table 4, organizational type homophily and transitivity effects remained significant in all the three models predicting communication network, furthering supporting H2 and H3a.

The same procedures were conducted for the three other networks. As summarized in Table 5, the model results remained consistent for the formal agreement network: H1 was not supported; H2 and H3a were supported in all models; and H3b, H3c, and H3d were not supported in any of the models. The latter indicated no significant effect of the organizational attributes on CBPR partners' formal agreement networks, except the homophily effect from the organizational type.

As summarized in Table 6, the reciprocity effect was not significant in any of the models, while the effect of transitivity was significant for the referring clients network in Models 2 and 3. Thus, H1 was not supported and H2 received some support. The homophiy effect from the organizational type was supported in Model 3. Therefore, H3a received some support, indicating that the same types of organizations tended to refer clients to each other. The effect of resource sufficiency, organizational influence, or perceived CBPR impact did not reach statistical significance in any of the models; hence, H3b, H3c, and H3d were not supported.

As in Table 7, the reciprocity effect was not significant in predicting receiving clients network ties. H1 was not supported. Both the transitivity effect and homophily effect from organizational type were significant in Models 2 and 3, supporting H2 and H3a. All other organizational attributes did not significantly predict the receiving clients network; hence, H3b, H3c, and H3d were not supported.

To answer the research question regarding the effect of multiplexity on CBPR partnerships, an exploratory approach was applied. First, a hypothesized model was tested to examine the role of communication network at Time 1 in predicting all other networks at Time 2, as well as the effect of any network at Time 1 on its subsequent network. The chi-square test was significant, $\chi^2 = 54.12$, degree of freedom [*df*] = 25, $p = .00064$. The ratio of χ^2 to degree of freedom was smaller than 5. Root mean square error of approximation (RMSEA) is .081. These results suggest that the proposed model was not a good fit to the data (Figure 1).

Second, to construct a better model the LISREL modification indices were used to add the following paths: referring clients network at Time 1 to formal agreement network at Time 2; receiving clients network from Time 1 to communication network at Time 2; and communication network at Time 1 to formal agreement network at Time 2. Furthermore, all the insignificant paths were deleted: communication network at Time1 to communication

network at Time 2; referring clients network at Time 1 to referring clients network at Time 2; and receiving clients network at Time 1 to receiving clients network at Time 2.

Third, the revised model was tested. The chi-square test was nonsignificant, $\chi^2 = 29.71$, $df = 25$, $p = .24$. The ratio of χ^2 to degree of freedom was smaller than 5 and he RMSEA was .033. Overall, these results suggested that the modified model was a good fit to the data and was significantly better than the null model. Given the chi-square, there was also an increase in overall model fit from the hypothesized model. All the paths in the revised model were significant. Therefore, the revised model was a better fit with the observed data at both global and local levels. It explained 1% of the variance of communication network at Time 2, 11% of the variance of formal agreement network at Time 2, 3% of the variance of referring clients network at Time 2, and 4% of the receiving clients network at Time 2.

The results from this finalized model (Figure 2) showed that the communication network at Time 1 significantly predicted the formal agreement network, receiving clients network and referring clients network at Time 2. The formal agreement network and referring client network at Time 1 both significantly predicted formal agreement network at Time 2. The receiving clients network at Time 1 significantly predicted communication network at Time 2, which also significantly predicted the formal agreement network at Time 2.

DISCUSSION

This study applied evolutionary theory to analyze the dynamics of the WINCART CBPR partnerships. The analysis reveals significant variation of network ties over time and provides empirical evidence that a myriad of factors, both endogenous and exogenous, drive interorganizational networking among CBPR organizations. The results demonstrated that network structure, in particular its transitivity, was related to the selection and retention of CBPR partnerships. The effect of organizational type on CBPR partnerships was also found significant, which supported the homophily effect. The findings suggest that transitive structures in the network help reinforce the sustainability of CBPR partnerships; however, more efforts should be placed to encourage the cross-sector alliance between universities and CBOs. However, the effects of other organizational attributes on communication networks did not achieve statistical significance. Organizations that are sufficient in resources did not receive more ties from others. Similar results were found on the variable of organizational influence and the perceived CBPR collaboration impact.

This raises the question as to whether resources still matter to CBPR partnerships. It is hard for CBOs to quantify physical, financial, or human resources. The way CBOs understand resources may be different than other types of organizations. For example, a potential partner’s connection to a church or the local community is more relevant to a CBO compared to the partner’s financial situation. In other words, CBO resources may comprise community social capital rather than human or material capital. In building and sustaining CBPR partnerships, more attention should be placed to uncover the multidimensionality of organizational resources and particularly the soft power of CBOs.

CBPR partnerships were defined by multiple network activities. The SEM findings showed that the role of communication network in driving CBPR partnerships was significant. If two organizations communicated in 2005 at the first time wave, they were more likely to set up a formal agreement and refer clients to or receive clients from each other in 2010 at the second time wave. If two organizations communicated at Time 2, they were also more likely to form formal agreement network at the same time period. This points to the importance of historical relations in shaping strategic partnerships (McKinney et al., 1993).

The analysis also showed that other networking activities significantly affect the sustainability of CBPR partnerships. If your organization received client referrals from other organizations, your organization would be more likely to communicate with them later on. If you referred clients to other organizations, you would be more likely to have a formal agreement with them later. The time effect was only significant on formal agreement networking, indicating that if two organizations had a formal agreement at Time 1, they tended to keep to the formal agreement at Time 2, which signaled an official partnership.

These findings have practical implications for CBPR programs. Previous studies have highlighted the role of multiplexity in influencing the dynamics of interorganizational networks, which means that different networking activities among various organizations influence the development of the organizational community (Lee & Monge, 2011). Given the important role the communication network played, efforts should be taken to encourage more communication among CBPR partners. Furthermore, given the value of forming formal agreement networks, more efforts should be placed to establish official partnerships among CBPR collaborating organizations.

Furthermore, this study also provides implication on how community psychologists could help with the building of community capacity and interorganizational coalition. Community-level intervention typically involves the creation of new settings to facilitate social interaction (Neal & Christens, 2014). Community psychologies should apply the network intervention strategy to build and sustain cross-sectional alliances among research institutes and local community organizations, along a variety of activities (Valente, 2012). They should also move beyond the traditional view of resource-oriented empowerment and identify organizations with more local access to the dissemination of information and policies in the development of a CBPR initiative. The existing interorganization networks should be used to form future strategic relationships for coordinated delivery of health services for local communities.

Limitations

This study has several limitations. First, the data are not representative of all CBPR programs. This article pertains to the WINCART collaborative. The major sources of the data were survey responses from community-based organizations, with a limited number of academic institutions. The findings may not be generalized to all CBPR partnerships. Second, there was significant variation of network ties over time; however, there was no significant change in all the behavior variables. This may partially explain why resource sufficiency, organizational influence, and perceived CBPR collaboration impact.

Third, the response rate at both time waves may influence the results. It is possible that participants who completed the surveys may differ from participants who did not, in terms of their commitment to WINCART, their tenure in their organization, or their expertise, all of which would cause nonresponse bias. Fourth, 38% of the survey participants from Wave 1 also answered the survey at Wave 2. This could be explained by the possible turnover within the WINCART partner organization. This might have increased the within-subject variance for the analysis at the organizational level.

Last but not least, there are potential sampling biases. As mentioned in the method section, the survey respondents were nominated by WINCART partner organizations. It is likely that these organizations tended to nominate employees who can portrait them in a more positive light. Given that in the survey all the organizational attributes were measured based on self-reported data from these nominated employees, this could affect the accuracy and reliability of the data (Calloway, Morrissey, & Paulson, 1993). Future study will include the amount of funding received by each organization or how organizations perceive other organizations' influence to compensate the measure of the perceived resource sufficiency. Network positions will be used to measure organizational influence (Valente, 2010).

Future study will also look at other measures of exogenous variables for CBOs, such as their social capital in local communities, given that CBOs are more concerned about access to local communities for disseminating knowledge and conducting research. With a more complete dataset, future studies might provide more insights in terms of how organizational attributes influence the dynamics of interorganizational networks and how the behavior variables and networking activities influence each other.

There were also methodological limitations. First, network ties were recoded as directional for all the four types of interorganizational relationship. The partnerships are reciprocal by nature. However, given that the network data were obtained by nomination from each side of the partnerships, there was asymmetry. The network data were coded in this way to reflect the initiative of each organization to network with others. Second, all the network datasets were dichotomized before the analysis, by taking the mean value of network density across all networks. However, it is possible that different networks may have different average levels of connection; thus, applying the same threshold for dichotomizing may not be the ideal solution. Future research will examine the effect of tie strength on the sustainability of CBPR partnerships.

Third, all the data collected from individual respondents were averaged to measure variables at the organizational level. This is based on assumption that the respondents from each organization had a comprehensive knowledge of the organization's network activities and other daily operations, which was ensured by the sampling of the respondents (see Tanjasiri et al., 2007, and Valente et al., 2010). However, it is possible that different respondents may have different views of the WINCART partnerships and future study would benefit from taking into account each respondent's job title in the analysis.

Conclusion

This study contributes to the literature on interorganizational networks and CBPR by applying the community ecological perspective to the analysis of the dynamics of CBPR partnerships and demonstrating that different factors play different roles in the selection and retention of partners. Endogenous network structure is related to the selection of CBPR partnerships, particularly the transitivity effect. The exogenous effect can be attributed only to the organization type. The importance of communication and formal agreement in sustaining CBPR partnerships reaffirms that communication and collaboration are sustained when formal agreements can be constructed.

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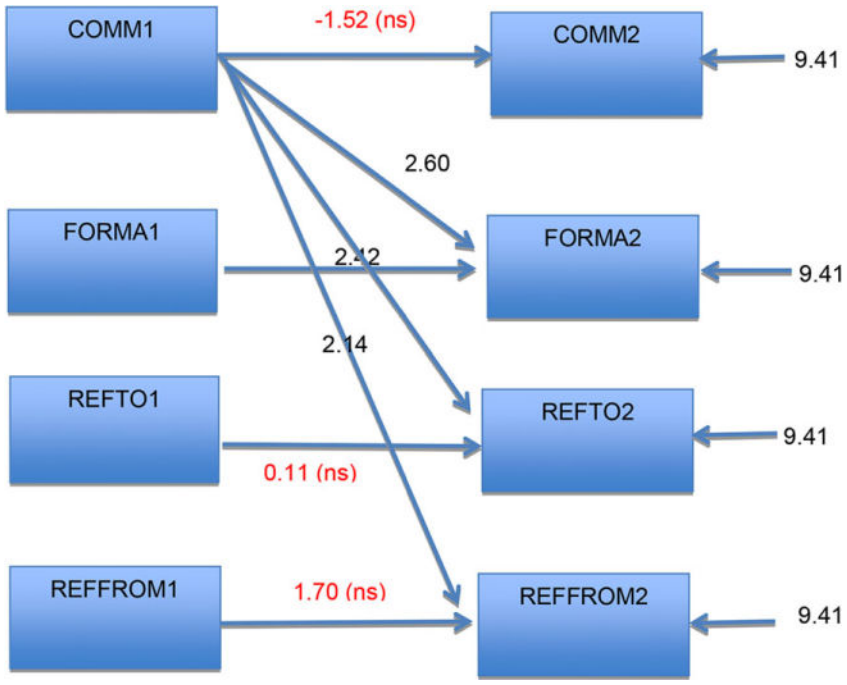

Figure 1.

Results from the hypothesized model.

Note. All exogenous variables are assumed to be independent from each other. Chi-square = 54.12; df = 25; p-value = 0.00064; RMSEA = −.081; ns = the path in red indicates that the hypothesized relationship was not significant.

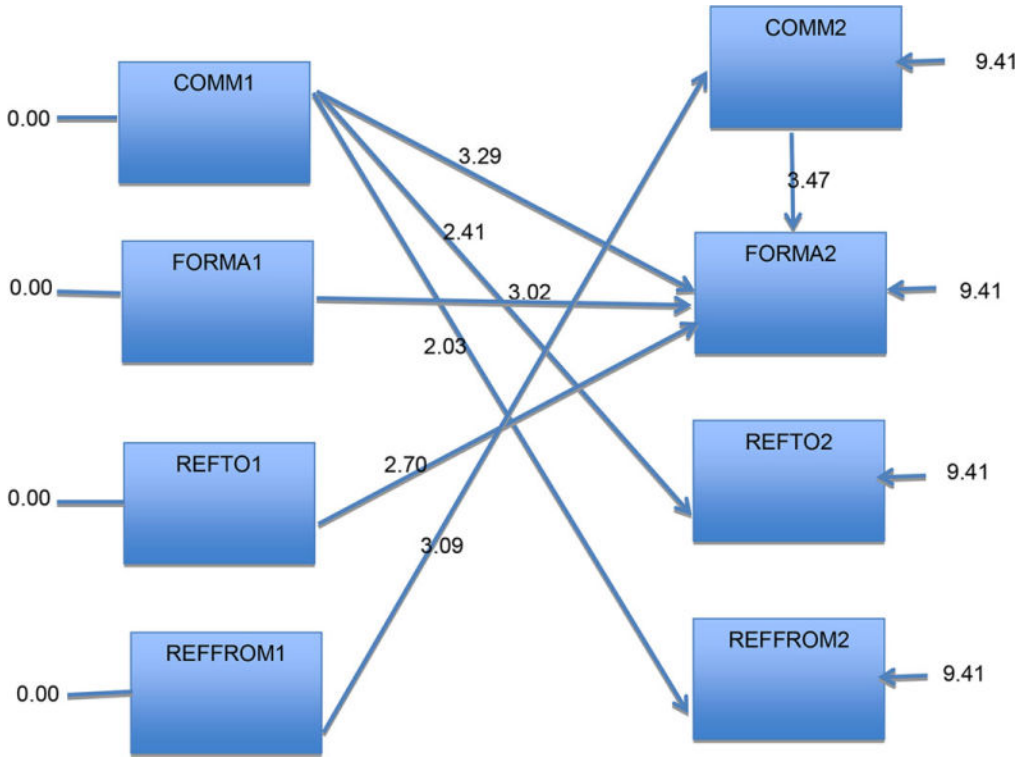

Figure 2.
Results from the revised model.
Note. Chi-square = 29.71; df = 25; p-value = 0.23544; RMSEA = 0.033.

Table 1

Summary of the Dataset

Characteristics	Time 1 (June 2005)	Time 2 (February 2010)
No. of responses	91	92
No. of responses per organization, mean	5.69	4.14
% of females	87.9	74.75
Tenure, mean	6.93	7.11
% participated in WINCART activities	58.6	58.62
No. of WINCART activities, mean	1.71	3.23
No. of links between organizations	1038	4684
No. of links within organization	146	356

Note. WINCART = Weaving and Islander Network for Cancer Awareness and Training.

Table 2

Descriptive Findings of the Networks

General CBPR networks	Density	Reciprocity	Indegree centralization	Outdegree centralization
Communication network 1	.60	.70	.16	.57
Communication network 2	.63	.77	.31	.45
Formal agreement network 1	.19	.80	.27	.55
Formal agreement network 2	.39	.66	.20	.70
Referring clients network 1	.33	.70	.19	.55
Referring clients network 2	.30	.64	.22	.79
Receiving clients network 1	.19	.71	.18	.54
Receiving clients network 1	.30	.64	.22	.79

Note. CBPR = community-based participatory research.

Table 3

Changes in Ties Across Two Time Periods

Periods	Network	0 = > 0	0 = > 1	1 = > 0	1 = > 1	Jaccard
1 = = >2	Communication	26	30	24	70	.565
1 = = >2	Formal agreement	89	51	15	20	.233
1 = = >2	Receiving clients	104	36	17	22	.293
1 = = >2	Referring clients	99	28	22	30	.375

Table 4

RSIENA Modeling of Communication Networks

	1			2			3		
Model	**Estimate**	**SE**	**t ratio**	**Estimate**	**SE**	**t ratio**	**Estimate**	**SE**	**t ratio**
Network structure									
Rate parameter	14.71	6.45	−.05	16.47	6.06	−.06	15.44	7.26	−.14
Density	−1.52	.50	.11	−1.59	.45	.12	−1.47	.39	.07
Reciprocity (H1)	.62	.89	.13	.94	1.00	.07	.66	.70	.07
Transitive triplets (H2)	.13	.06	.08	.05	.07	.07	.13	.05	.01
Organizational attributes									
Same organizational type (H3a)	.79	.30	.10	.72	.32	.11	.75	.32	.04
Resource sufficiency alter (H3b)	.31	.69	−.06						
Organizational influence (H3c)				−.29	.41	−.05			
CBPR impact alter (H3d)							−.01	.18	−.05

Note. SE = standard error; CBPR = community-based participatory research.

Table 5

RSIENA Modeling of Formal Agreement Networks

	1			2			3		
Model	**Estimate**	**SE**	**t ratio**	**Estimate**	**SE**	**t ratio**	**Estimate**	**SE**	**t ratio**
Network structure									
Rate parameter	15.00	6.04	.07	15.70	3.70	.03	16.12	5.29	.06
Density	−1.41	.28	.09	−1.36	.31	.07	−1.33	.25	.09
Reciprocity (H1)	.28	.67	.06	.37	.50	.07	.32	.47	.08
Transitive triplets (H2)	.26	.14	.04	.25	.12	.04	.25	.10	.04
Organizational attributes									
Same organizational type (H3a)	.51	.26	.08	.49	.21	.07	.48	.23	.08
Resource sufficiency alter (H3b)	.26	6.23	−1.00						
Organizational influence (H3c)				−.14	.36	−.06			
CBPR impact alter (H3d)							−.05	.16	−.04

Note. SE = standard error; CBPR = community-based participatory research.

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Table 6

RSIENA Modeling of Referring Clients Network

	1			2			3		
Model	**Estimate**	**SE**	**t ratio**	**Estimate**	**SE**	**t ratio**	**Estimate**	**SE**	**t ratio**
Network structure									
Rate parameter	7.68	2.97	−.03	9.84	2.59	−.05	9.82	3.01	−.04
Density	−1.76	3.19	.04	−1.36	.29	.04	−1.37	.27	−00
Reciprocity (H1)	.27	.57	−01	.06	.40	.01	.06	.37	.01
Transitive triplets (H2)	.21	.13	−00	.23	.08	.01	.23	.08	−.03
Organizational attributes									
Same organizational type (H3a)	.55	.36	−.06	.00	.23	.04	.50	.25	−.00
Resource sufficiency alter (H3b)	1.05	4.43	−.01						
Organizational influence (H3c)				.02	.43	.02			
CBPR impact alter (H3d)							.60	.17	−.03

Note. SE = standard error; CBPR = community-based participatory research.

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Table 7

RSIENA Modeling of Receiving Clients Network

	1			2			3		
Model	**Estimate**	**SE**	**t ratio**	**Estimate**	**SE**	**t ratio**	**Estimate**	**SE**	**t ratio**
Network structure									
Rate parameter	9.53	9.41	.00	11.06	3.49	−.06	11.32	3.04	−.01
Density	−1.55	1.37	.03	−1.29	.23	.02	−1.29	.25	−.05
Reciprocity (H1)	.29	.77	−.01	.16	.43	.00	.13	.38	−.05
Transitive triplets (H2)	.23	.14	.02	.24	.08	−.00	.23	.08	− 08
Organizational attributes									
Same organizational type (H3a)	.56	.82	.01	.49	.25	.01	.49	.23	−.05
Resource sufficiency alter (H3b)	.69	2.32	−.02						
Organizational influence (H3c)				−.01	.33	−.00			
CBPR impact alter (H3d)							.09	.18	.06

Note. SE = standard error; CBPR = community-based participatory research.