Psychosocial Intervention

Centrality measures to identify key stakeholders in Family Violence Councils

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A B S T R A C T

The Family Violence Councils (FVC) are collaborative settings that bring together various organizations involved in the systems response to family violence. Social network analysis (SNA) is a technique that allows one to assess the connections between members (e.g., agencies) within a particular bounded network (Scott, 1991) and is well-suited to the study of councils. Centrality measures in SNA indicate which members in the network are central and prominent players in the setting, and therefore might be critical to engage in change efforts. The current study applied three centrality measures in five councils to identify consistent patterns regarding which organizations tend to be most central in the exchange of information among agencies responding to family violence. Further, the study examined whether and which type of centrality was related to the degree to which a given organization's policy and practices were influenced by council efforts. The study found domestic violence programs were significantly more likely to emerge as central in these settings. The study also found a relationship between an organization's centrality and perceived shifts in its policy and practices. However, only one type of centrality measure, namely closeness centrality, emerged as significantly predicting outcomes of interest when all three were examined simultaneously. The implications of these findings for research and practice will be discussed.

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Las medidas de centralidad en la identificación de las partes interesadas en los Consejos de Violencia Familiar

R E S U M E N

Los Consejos de Violencia Familiar (Family Violence Councils, FVC) son espacios de colaboración que reúnen a diversas organizaciones que participan en el sistema de respuesta a la violencia familiar. El análisis de redes sociales (ARS) es una técnica que permite evaluar las conexiones entre los miembros de una red concreta (por ejemplo, agencias de servicios) (Scott, 1991) y es muy adecuada para el estudio de los consejos. Las medidas de centralidad en ARS indican qué miembros de la red son centrales y prominentes en un contexto determinado, y por tanto puede ser fundamental implicarlos en los esfuerzos de cambio. En este estudio aplicamos tres medidas de centralidad en cinco consejos, para identificar patrones consistentes en el intercambio de información entre las entidades que intervienen contra la violencia familiar. Además, con esta investigación examinamos si la centralidad se relaciona con el grado en que las políticas y las prácticas de una organización determinada fueron influenciadas por los esfuerzos del consejo. Los programas de violencia doméstica eran con mayor probabilidad centrales en los contextos analizados. También encontramos una relación entre la centralidad de la organización y los cambios percibidos en su política y sus prácticas. Sin embargo, sólo un tipo de medida de centralidad, concretamente la cercanía (closeness), predijo los resultados de interés cuando se tuvieron en cuenta las tres simultáneamente. Se discuten las implicaciones de estos hallazgos para la investigación y la práctica.

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Collaboratives are popular structures formed to address systems change in response to various social issues (e.g., domestic violence, child welfare services, juvenile delinquency, community health; Berkowitz, 2001). Collaboratives include coordinating councils, community-based coalitions, and interagency teams (herein referred to as councils; Allen, Watt, & Hess, 2008; Berkowitz, 2001; Wolff, 2001) and typically bring together various stakeholders to promote an integrated response to complex issues. Frequently, interagency coordination is the specific method encouraged to produce such an integrated response across organizational boundaries (Alter, 1990). That is, councils encourage multiple organizations to work together as part of a coordinated whole by, for example, exchanging information, making referrals to one another, and sharing resources (e.g., Foster-Fishman, Salem, Allen, and Fahrbach, 2001; Himmelman, 2002). Given the emphasis on interagency coordination, social network analysis (SNA) provides a potent tool for examining such connectivity.

The current study explores the use of a specific class of network indices, centrality indices, to examine the nature of interagency coordination in the form of information exchange, as well as the role that specific organizational types play in encouraging such exchange. Examining centrality can provide a picture of the specific roles organizations take within inter-organizational collaborative networks. Each approach to centrality has a different theoretical framework for determining centrality: degree centrality is based on social capital theories (e.g., Mandarano, 2007), betweenness centrality is based largely on brokering theories (Burt, 1995), and closeness centrality has yet to be theoretically explored, but has been most closely associated with the speed of diffusion of information (Freeman, 1979). The former centrality measures have been explored at the individual and organizational levels, while closeness has been examined primarily at the individual level. Yet, it is not clear which of these is most relevant to the study of collaborative phenomenon. Examining centrality in councils, and the theories behind each type, expands the current literature on network structures by contributing to theories of centrality in collaborative settings. Further, the current study examines how and to what extent each centrality measure is related to the degree to which a given organization's policy and practices are influenced by council efforts (in terms of perceived changes in policy and practice).

The case of Family Violence Councils (FVC)

The current study focused on Family Violence Councils (FVC; herein referred to as FVC or councils). These councils are formed to improve the systems response to family violence by encouraging interagency linkages between domestic violence service providers and criminal justice agencies, in particular. The FVC are organized by judicial circuits in the State. Judicial circuits are regions organized by the State court system and typically include multiple counties. Thus, the FVC in the current study have strong ties to the judicial system and are typically chaired by Chief Judges of the circuit or their appointees. The local FVCs in the circuit get funding and technical assistance from the State Family Violence Coordinating Council and its state staff. Each local FVC attempts to engage the various organizations in the circuit (both within and across counties) that are involved in the systems response to family violence. These organizations include, for example, domestic violence shelters, batterer's intervention programs, child welfare agencies, law enforcement, probation, and courts. As their name would imply, the councils aim to increase interagency coordination in their response to family violence. This includes not only working in a more coordinated fashion, but informing and shaping inter- and intra-organizational practices through collaborative work. For

example, FVCs have created protocols to enhance the response to elder abuse by including the perspectives of multiple constituencies including elder care services, law enforcement, and domestic violence advocates. Each brings a unique perspective that shapes not only new protocols for their own organizations, but potentially for the protocols and practices of other partners (e.g., advocates shaping law enforcement practices).

In a given circuit, some of the critical responding organizations are active members in the council, some are peripherally involved in the council, and some are non-members, or not actively involved in council efforts. The active member organizations may be particularly important for a given local FVCs efforts, because they are likely to be better connected with other organizations than are more peripheral members or non-members (Allen, 2005). Therefore, identifying those agencies within a network that are both active and central members in the network may reveal the specific nature of the diffusion of new knowledge or innovation throughout the network. Further, identifying which organizations are central using different criteria of centrality will allow a comparison of centrality types by examining whether similar organizations emerge as central in each type. Finally, examining multiple centrality types allows for a study of how they are related to the degree to which organizations adapt changes because of council efforts.

Social network analysis

Social network analysis (SNA) is a technique that allows one to assess the linkages between members within a particular bounded network (i.e., network with a clearly defined set of members; Scott, 1991). SNA is well suited to the study of councils because it has a variety of tools that can be used to assess interagency linkages, including, for example, information exchanges, and the relationships between members in a setting of interest. One set of tools is the indices of network centrality, or metrics that capture the extent to which an actor in the network is connected to other actors in the network. In this study, settings refer to given networks of councils, and actors refer to the organizations that are part of the council networks.

Centrality measures

Centrality is an important structural attribute of social networks. It is related to other group properties and processes (Freeman, 1979), including, for example, which member in the group has access to more information. Borgatti, Mehra, Brass, and Labianca (2009) in a recent review of network theory and literature state that a "fundamental axiom" in network research is that an actor's (or *node* in network language) position in the network determines in part the opportunities and constraints the actor encounters, "and in this way plays an important role in a node's outcomes" (p. 894). An organization's power is then a result of the power of all other organizations in the network, and the organization can be affected by changes in the network far away from it (Borgatti et al., 2009). Thus, the more central an organization is the more powerful or influential its position in the network is, or the more central an organization the better positioned it is to be influenced by the efforts of the collaborative network.

The current study will apply three different types of centrality measures, degree, betweenness, and closeness, in five coordinating councils to identify patterns regarding which organizations tend to be most central in the networks and to examine how these are similar and/or different based on the particular measure of centrality. Identifying central organizations may reveal which organizations need to be engaged to most effectively diffuse information and knowledge among such organizations.

a

b

c
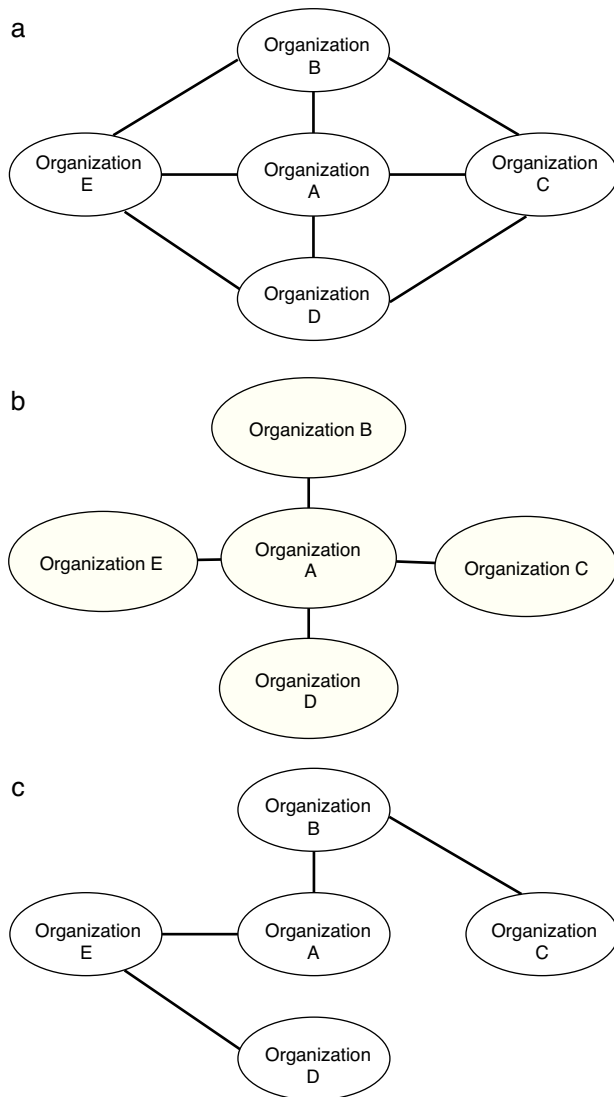
Fig. 1. (a) Degree centrality. Organization A has highest degree centrality. (b) Betweenness centrality. Organization A has highest betweenness centrality. (c) Closeness centrality. Organization A has highest closeness centrality.

Degree centrality

The three most common conceptualizations of centrality were described by Freeman (1979) in his seminal paper. The first is "degree centrality". In these settings, the degree of a particular organization is the number of other organizations it is adjacent to or in direct contact with (Freeman, 1979; See Fig. 1a). For communication networks, organizations with high degree centrality have high visibility or "potential for activity" (Freeman, 1979). Information exchange networks can be conceptualized as communication networks. An organization that has high degree centrality has access to a lot of direct information because it has direct contact with many other organizations. Thus, this organization may be "in the know" by virtue of these ties.

In terms of interagency coordination, organizations with high degree centrality might be critical for access to information or other resources in the field of interest since they are likely to be the most well informed because of their extensive connections and relationships with other organizations. To illustrate, in a social network analysis of social capital in collaborative planning settings, Mandarano (2007) examined degree centrality as an indicator of each actor's social capital. The study examined a

regional collaborative environmental partnership and found that the United States Environmental Protection Agency (US EPA), along with other governmental agencies, consistently emerged as the central organization across different types of exchange networks. Mandarano (2007) suggests this information can be used to illustrate gaps in resource and funds exchange networks to revisit activities to bridge those gaps (in this case with non-governmental agencies). Such an approach could be used with the FVCs to identify organizations that have the most access to information in the network by means of their extensive connections with others.

Betweenness centrality

The second type of centrality that Freeman (1979) describes is "betweenness centrality". The betweenness centrality of a given organization is the frequency with which the organization falls in between pairs of other organizations on their geodesic distances (i.e., shortest distance between two organizations). Organizations with high betweenness centrality are seen as powerful brokers in a network because they have the potential to cut other organizations' information sources (Freeman, 1979). However, in the study of councils, another way to think about an organization with high betweenness centrality is as an organization that has the potential for bringing together organizations that would otherwise not be in contact and therefore as bridges or connectors of agencies (see Fig. 1b). By examining betweenness centrality in collaborative settings, it is possible to identify organizations that might serve as "information brokers" that connect various stakeholders and therefore increase interagency coordination.

For example, Berardo (2009) examined U.S. estuaries and found that for complex interagency teams, such as the estuary settings, it might be more cost effective to increase the connections between various stakeholders through other central organizations rather than create a densely connected team overall. The estuary settings are similar to the FVC in that they both are created to bring together various governmental and non-governmental organizations to address a common concern. Given this similarity, betweeneness centrality may be an important component of efficiency in communication in the FVC networks by creating hubs of information exchange.

Closeness centrality

The last notion of centrality Freeman (1979) describes is "closeness centrality", which measures how close an organization is to all other organizations (i.e., how many lines does it take to connect a given organization to all of the other organizations in the network, on average?). Closeness centrality is also related to control of information but in a different way than betweenness. An organization is central to the extent it can avoid being controlled by others because it is so closely connected to many organizations and therefore not dependent on any single organization to be linked to a network; it illustrates the importance of interdependency in networks. The more organizations Organization A is connected with, the more sources of information it will have, and the better informed it will be (see Fig. 1c). Organizations that have low closeness centrality are in a vulnerable position to not be well informed because they are not well connected to other organizations. The organization that is most central using this measure is the one to target if one wants to minimize the cost and time for communicating to all other points (Freeman, 1979). When considering interagency coordination, this may be particularly valuable because identifying the central organization that needs to be engaged for the timely dissemination of information might be critical for effective coordination efforts.

This is particularly true when a given organization is critical to the effective implementation of a given effort.

Centrality and council influence

It is also important to understand how centrality relates to the degree to which given organizations are affected by council efforts to produce change. That is, how likely an organization is to benefit from collaboration may depend on its position in the collaborative network (Borgatti et al., 2009). FVCs are particularly concerned with stimulating policy and practice changes in the network of organizations responding to family violence. This follows an emphasis on producing changes "in the text" that govern the response of front-line providers (Pence, 1999). The extent to which an organization is centrally located in a network may make it more susceptible to influence via council efforts. That is, the organizations that are centrally located, and thus have access to information and resources in the collaborative network, are better poised to make informed changes to their policy and practice in response to FVC efforts. Those that are less central may be less subject to influence because they are not well connected to the core of information exchange occurring in the network. Further, different types of centrality may function differently in relationship to organizational change in policy and practice.

Current study

The current study, therefore, examines three actor centralities (i.e., degree, betweenness, and closeness) in the information exchange networks of five Family Violence Councils to identify the key players in those networks. While exchange of information is a key aspect of coordination, very few studies have examined which organizations, or organization types, are central in information exchange networks among the member organizations of collaborative settings. By identifying possible organizations that are key players in information exchange networks, the current study aims to identify organizations that are critical to engage for effective diffusion of knowledge and coordination efforts in collaborative settings, such as Family Violence Councils. Further, although previous studies have utilized one or more types of centrality in their methods, no study to date has looked at the three primary types of centrality (i.e., degree, betweenness, and closeness) in information exchange networks in the same setting and across five such settings. The comparison of multiple settings within the current study allows for greater generalizability, while the use of multiple measures of centrality yields results that have the potential to lead to a more nuanced understanding of information exchange and the role of centrality in collaborative settings.

Finally, the current study examines how centrality is related to the extent to which given organizations have been influenced (in terms of perceived change in policy and practice) by FVC efforts. Given the goal of councils to facilitate such organizational change, the current study examines the relationship between centrality and peer-ratings of an organization's shifts in practice and policy as a result of council efforts. This allows for an examination of the extent to which centrality – in its different forms – is related to the degree to which organizations are affected by the systems change work of FVCs.

Research questions

The current study examines three questions. First, which organizations emerge as central in FVCs (e.g., domestic violence programs, law enforcement, courts) based on each type of centrality? Second, which centrality type has the most predictive value regarding other desired outcomes for councils? Lastly, using the information from the first two questions, which type of centrality is important for outcomes of interest in collaborative settings.

Method

The current study was part of a larger study on the FVCs in the state. For this study, five representative and exemplar local FVCs from the state were chosen. These sites were chosen based on (a) geographic representativeness (i.e., different locations throughout the state; with different compositions in terms of urban, sub-urban and rural counties), (b) structural make-up (FVCs vary in terms of their subcommittee structure being aligned with substantive issues, like law enforcement response, that are circuit wide and span multiple counties or subcommittees that focus on the response to family violence within given counties), and (c) being generally viewed as settings that have had some important successes. General descriptive information about the five circuits examined in this study is presented in Table 1. Since the network survey was only sent to members of local FVCs, only member response rates could be calculated (i.e., nonmember response rates were zero, by design). However, to reflect a complete network for a given FVC (i.e., one that had all of the key responding agencies), network rosters had both member and non-member organizations on them (see below). Member response rate was calculated by dividing the number of responding organizations by the number of member organizations on the network roster. For the five sites examined in this study, member response rates ranged from 42.4% to 70.6% (see Table 1). This is a typical range for survey data gathered via mail (see Anseel, Lievens, Schollaert, & Choragwicka, 2010).

Network bounding

To conduct network analysis a variety of methodological decisions must be made. The first of these is how to "bound" the network, or choose which actors should be included in the network roster. Each judicial circuit constituted a separate and unique network of organizations responding to intimate partner violence, including organizations at the circuit (i.e., courts, domestic violence shelter programs), county (sheriff's office, state's attorney) and local (e.g., municipal police, local agencies) levels. For the purpose of this study, in a given circuit all domestic violence programs (DV), batterer's intervention programs (BI), courts (C), probation departments (P), sheriff's offices (LE), State's Attorneys (SA), and police departments (LE) were included.[1] It is important to note that in each circuit, not all relevant agencies were current council members or affiliates. Thus, the network list (or roster) used to survey potential affiliates within each circuit was formed in a two-stage process. First, all relevant agencies that were included in councils' membership lists were included on the survey roster. Second, any agencies not included as council affiliates, but that played a role in the criminal justice response to intimate partner violence were added (e.g., circuit clerk, states attorney). Resultant network survey rosters included all agencies that could be involved in a coordinated response to intimate partner violence, some of which were

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[1] For circuits that were large and had numerous police departments, a random sample of departments was included in its network roster. This was important because we wanted to ensure that at least one city police department was included in the network list for each county in a judicial circuit. Therefore, we compiled a list of all city police departments for each county of each circuit. For each county, we used a random number generator to pick one random city police department that was not part of council membership. In most cases, this resulted in adding as many random police departments as there were counties in a Circuit. Using random sampling in this fashion was critical given that some network lists would be unduly large if all non-member municipal law enforcement agencies were included.

Table 1
Description of circuits.

Site	Square miles	Number of counties	Council structure	Total number of organizations	Number of member organizations	Percent of member organizations that responded
Circuit A	1123	2	Primarily focused on one county	24	17	70.6%
Circuit B	3946	6	Circuit wide	75	19	63.2%
Circuit C	1482	3	Mix of circuit and county level organization	35	19	57.9%
Circuit D	4812	12	Circuit wide	89	59	42.4%
Circuit E	5446	9	Circuit wide	73	50	54%

members and some of which had no council affiliation (i.e., non-members). Even though only committee member agencies were asked to respond to the survey, the inclusion of both member and non-member agencies' names on the network roster was useful given the aim was to assess member organizations' connections with one another *and* with non-member agencies within their Circuit networks. This allowed us to begin to establish patterns of interaction among the full network of responders and to examine their exchange of information in light of council membership.

Measures

Exchange of information

Members were surveyed regarding their contact with all of the agencies identified as part of the network. Specifically, respondents were asked to report how often they exchanged information with each organization in their Circuit's network list (using a six-point Likert-type scale; 1 = never, 2 = once/year, 3 = twice/year, 4 = monthly, 5 = weekly, 6 = daily; these value were recoded from 0 to 5 for all subsequent network analyses). Respondents also had the option of checking a "no knowledge of, contact with or opinions about" box for each organization. Each organization was listed in a separate row on the survey, and respondents considered the full set of ties for each organization listed in the network roster. The membership status of organizations was not indicated in the roster. If a respondent had checked the "no knowledge of, contact with or opinions about" box for an organization, the exchange of information tie was coded as "never".

Peer ratings of organizational change as a result of council efforts

For each organization in the roster, respondents were also asked to rate the degree to which they perceived that membership in the council had (a) changed policy and procedure within the organization and (b) changed the practices of the organization (using a four-point Liker-type scale; 1 = not at all, 4 = a lot, and 7 = don't know). If a respondent had checked the "no knowledge of, contact with or opinions about" box for an organization, the two perceptual variables (i.e., changes in policy and procedure and changes in practices) were coded as missing. Thus, the resultant score is a peer rating, generated by respondents who have at least some contact or knowledge of the target agency. Given the high correlation between the two dependent variables ($r = 0.961$), they were combined by taking the mean of the two variables for all subsequent analyses.

Member status

A membership variable was created with 1 = member and 0 = non member, and each organization was categorized on this variable. This variable was created to include in subsequent regression analyses, given that an organization's membership in an FVC makes it more susceptible to influence by the FVC when compared to non-members.

Sector

A sector variable was created to indicate which system (or sector) in the response to intimate partner violence an organization belonged to. The possible values for this variable were 1 = domestic violence (DV) program, 2 = batterer's intervention program, 3 = law enforcement, 4 = court, 5 = probation, 6 = state's attorney, and 7 = Department of Children and Family Services (DCFS). Each organization was categorized on this variable. After the initial categorization, the sector variable was recoded into six dummy coded variables with domestic violence program being the referent group.

Procedures

Responses regarding the exchange of information across agencies were used to calculate the three different types of node centrality (i.e., degree, betweenness, and closeness). Network tie data were gathered at the level of individual council members, who responded as representatives of their respective agencies. To form a network matrix at the organizational level, the individual member-level database was aggregated to the organizational level. If a single organization had more than one respondent, then the mean score of multiple respondents' scores within that organization was used to compute one score for the whole organization. In the aggregate network matrix, a row was included for each organization on the survey roster, including organizations from which we did not receive a survey response.

Analyses

UCINET software (Borgatti, Everett, & Freeman, 2002) was used for all social network analyses. Given that social network analysis software requires a complete matrix (i.e., a perfect square matrix of actors X actors), missing data were replaced with 0 s ("no tie"). However, in subsequent steps we used *unconfirmed* ties (i.e., where contact between two agencies is established if either one reports a connection; so if a survey respondent indicated having a tie with a survey nonrespondent, then we took the respondent's word that a tie existed), and exchanges were indicated based on either organization in a given dyad indicating they had contact.[2] Thus, in situations where no data were available contact could be established based on the report of only one organization within a given dyad.

To calculate unconfirmed ties, the matrix was made symmetric using the maximum of the two data points generated by any two organizations within the network. The matrix was also made

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[2] For example, person 1 from Organization A reports exchange of information with Organization B. However, person 2 from Organization B indicates no contact with Organization A. To reflect the most comprehensive exchange of information between Organization A and B, one has to consider person 1's unconfirmed tie. This is a common approach when key informants are utilized to establish ties between agencies (see Foster-Fishman et al., (2001) for an application of this approach).

dichotomous so that ties indicating any contact (i.e., at least annual contact) received a "1" and no contact received a "0". Once the symmetric and dichotomous matrices for each council were uploaded to UCINET, the three centrality measures were calculated for each council's network.[3]

Regression analyses were done to see the relationship between the centrality measures and the combined perceptual variable regarding perceived changes in policy and practice due to membership in the council, while controlling for the effects of the circuit size on centrality. To control for circuit size, four dummy coded variables were created for Circuit A–Circuit D, with Circuit E being the referent group. These four dummy variables were entered in all regression analyses as control variables. Four separate hierarchical regression analyses were done. Three of these had an organization's membership status and the four dummy coded circuit variables as control variables, one of the centrality measures (i.e., degree, betweenness, and closeness) as predictor variables, and the combined perceptual variable (i.e., perceived changes in policy and practice) as a criterion variable. The other hierarchical regression analyses had an organization's membership status and the four dummy coded circuit variables as control variables, all three centrality measures as predictor variables, and the perceptual variable as a criterion variable. Additionally, three more hierarchical regression analyses were done to see if there was a relationship between organization type (i.e., sector) and centrality. For these analyses, the four dummy coded circuit variables were the control variables, the six dummy coded sector variables were the predictor variables, and one of the centrality measures (i.e., degree, betweenness, and closeness) was the criterion variable.

Results

Freeman's degree centrality

Freeman's degree centrality was calculated on the complete network across all five circuits. The three most central organizations in each circuit are given in Table 2. As can be seen from the table, a domestic violence program emerged as a central organization in all sites except Circuit B, indicating that in most Circuits, Domestic Violence Programs tended to have more direct connections with other organizations in their networks. However, it is important to note that Domestic Violence Programs were not the most central organizations in every circuit. Law enforcement organizations, namely Local Police Departments, State Police, and County Sheriff's Departments, were also highly central.

Freeman's betweenness centrality

For Freeman's betweenness centrality, again the complete network was examined for the five circuits and the results are given in Table 2. Most of the same organizations emerged as central using the betweenness index as those using the degree centrality index. It is important to note that more Domestic Violence Programs emerged as central using the betweenness index than the degree index, indicating that Domestic Violence Programs are even more important as bridges between otherwise unconnected organizations in the network. However, Domestic Violence Programs are still not central in Circuit B.

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[3] For those networks that had isolates (i.e., organizations that had no connections with any other organizations in their network), just the connected network was extracted from the overall network to measure closeness centrality since this measure of centrality can only be calculated on connected networks. The other two indices of centrality (i.e., degree and betweenness) were calculated on the full network for each council.

Freeman's closeness centrality

Circuit D had isolates (i.e., organizations that were not connected to any other organizations in the network) in its network, and therefore the closeness centrality could not be calculated for its complete network. Therefore, the main component, or the connected network, was extracted from the complete network and the closeness centrality analyses were only done on the main component for Circuit D. For the other four circuits, the closeness centrality analyses were done on the complete network, and the results are presented in Table 2. Again, the only change between the degree centrality table and the closeness centrality table is in favor of a Domestic Violence Program, illustrating that Domestic Violence Programs are also closely connected, in addition to being connected to many other organizations in their networks. This phenomenon is a result of the strong correlation between the various types of centrality in this sample, and suggests that even though other organizations might have to rely on Domestic Violence Programs for access to information in their networks, Domestic Violence Programs are fairly independent (i.e., they do not have to rely on others for information), thus making them less vulnerable to being cut-off from access to information.

Centrality and council influence

All regression analyses were significant ($p < 0.01$), even after controlling for circuit size and membership. For analyses with peer-ratings of changes in policy and procedures as the criterion variable, the degree centrality coefficient ($\beta = 0.306$, $t(292) = 5.126$, $p = .000$), the betweenness centrality coefficient ($\beta = 0.148$, $t(292) = 3.016$, $p = .003$), and the closeness centrality coefficient ($\beta = 0.364$, $t(291) = 6.209$, $p = .000$) were all significant. However, when all three centrality measures were entered together as predictor variables, only closeness centrality was significant ($\beta = 0.597$, $t(291) = 3.754$, $p = .000$; see Table 3). The probable reason for degree centrality and betweenness centrality no longer being significant predictors of the outcome variables when examined concurrently with closeness centrality is the high correlation between the three centrality indices (see Table 4). When all three are examined simultaneously, only the centrality index accounting for the most variance (i.e., closeness centrality) emerges as a significant predictor.

To examine whether a particular organization type (i.e., sector) was more likely to be central, three hierarchical regression analyses were done with dummy coded circuit variables as control variables, dummy coded sector variables as the predictor variables, and each of the three centrality indices as the criterion variable (see Tables 5–7). For degree centrality and closeness centrality, four of the six sector regression coefficients were significant. Except for State's Attorney and DCFS, all the other sectors were significantly less likely to be central using these two indices than domestic violence programs (i.e., the referent group). For betweenness centrality, only the DCFS coefficient was not significant, meaning all the other sectors were less likely to be central than domestic violence programs. One of the reasons that DCFS and State's Attorney comparisons with domestic violence are not significant might be that there are significantly fewer organizations in these two sectors than in the domestic violence program sector. For example, every circuit only has one DCFS, making the total number of DCFS agencies in the sample five. Therefore, even if only one DCFS agency emerged as central in the sample (i.e., Circuit D), then DCFS is disproportionately represented as central in the sample. These results indicate that, overall, domestic violence programs are more likely to be central players in Family Violence Councils.

Table 2
Central organizations by centrality type.

Circuit	Centrality type	1st central organization	2nd central organization	3rd central organization
Circuit A	Degree	Domestic Violence Program	County Probation department	Police department
	Betweenness	Domestic Violence Program	County Probation department	Police department
	Closeness	Domestic Violence Program	County Probation department	Police department
Circuit B	Degree	State Police	Police department	State's Attorney's Office
	Betweenness	Police department	State Police	State's Attorney's Office
	Closeness	State Police	Police department	State's Attorney's Office
Circuit C	Degree	Domestic Violence Program	County Judiciary/Courts	Domestic Violence Program
	Betweenness	Domestic Violence Program	Domestic Violence Program	Domestic Violence Program
	Closeness	Domestic Violence Program	County Judiciary/Courts	Domestic Violence Program
Circuit D	Degree	Department of Child and Family Services	Domestic Violence Program	County Sheriff's Office
	Betweenness	Domestic Violence Program	Department of Child and Family Services	County Probation Department
	Closeness	Department of Child and Family Services	Domestic Violence Program	Domestic Violence Program
Circuit E	Degree	County Sheriff's Office	County Judiciary/Courts	Domestic Violence Program
	Betweenness	County Sheriff's Office	County Judiciary/Courts	Domestic Violence Program
	Closeness	County Sheriff's Office	County Judiciary/Courts	Domestic Violence Program

Table 3
All centrality measures as predictors of perceived changes in policy and practice.

Variable	Model 1			Model 2		
	B	$SE\ B$	β	B	$SE\ B$	β
Constant	1.458	0.043		0.254	0.308	
Member	0.253	0.038	0.340**	0.106	0.043	0.143*
Circuit A	−0.192	0.070	−0.142**	−0.321	0.073	−0.238**
Circuit B	−0.408	0.052	−0.481**	−0.421	0.049	−0.496**
Circuit C	−0.076	0.061	−0.066	−0.057	0.060	−0.050
Circuit D	−0.193	0.047	−0.238**	−0.052	0.051	−0.064
Degree				−0.003	0.004	−0.129
Betweenness				−0.009	0.006	−0.124
Closeness				0.025	0.007	0.597**
R^2		0.365			0.450	
Change in R^2		0.365**			0.085**	

Note: N = 296.
* $p < .05$.
** $p < .01$.

Table 4
Intercorrelations between the predictor and criterion variables.

Variable	1	2	3	4	5	6
1. Member	–	0.501	0.296	0.459	0.466	0.455
2. Degree		–	0.749	0.948	0.415	0.410
3. Betweenness			–	0.711	0.243	0.233
4. Closeness				–	0.409	0.406
5. Change in policy					–	0.961
6. Change in practice						–

Note: N = 296.

Table 5
Sector as predictor of degree centrality.

Variable	Model 1			Model 2		
	B	$SE\ B$	β	B	$SE\ B$	β
Constant	18.493	1.866		26.783	3.034	
Circuit A	20.275	3.751	0.311**	21.068	3.638	0.323**
Circuit B	−7.322	2.621	−0.179**	−6.239	2.556	−0.152*
Circuit C	3.692	3.278	0.067	4.316	3.188	0.078
Circuit D	−9.019	2.517	−0.232**	−8.363	2.422	−0.215**
Sector 7				10.530	7.375	0.076
Sector 6				−4.451	3.835	−0.078
Sector 5				−8.532	3.835	−0.149*
Sector 4				−12.955	3.324	−0.300**
Sector 3				−10.626	3.053	−0.296**
Sector 2				−23.227	8.221	−0.151**
R^2		0.211			0.288	
Change in R^2		0.211**			0.078**	

Note: N = 296.
* $p < .05$.
** $p < .01$.

Table 6
Sector as predictor of betweenness centrality.

Variable	Model 1			Model 2		
	B	SE B	β	B	SE B	β
Constant	1.259	.568		5.074	0.909	
Circuit A	1.837	1.141	0.103	2.051	1.090	0.115
Circuit B	0.099	0.797	0.009	0.478	0.766	0.043
Circuit C	1.578	0.997	0.105	1.632	0.956	0.109
Circuit D	0.006	0.766	0.001	0.302	0.726	0.029
Sector 7				2.363	2.211	0.063
Sector 6				−3.948	1.150	−0.253[**]
Sector 5				−4.399	1.150	−0.281[**]
Sector 4				−4.933	0.996	−0.418[**]
Sector 3				−4.677	0.915	−0.477[**]
Sector 2				−6.486	2.464	−0.154[**]
R^2		0.019			0.141	
Change in R^2		0.019			0.122[**]	

Note: N = 296.
[**] $p < .01$.

Discussion

The purpose of this study was to explore what organization types emerged as central in Family Violence Councils (FVCs), and to examine whether centrality was related to the extent to which council efforts affected change in organizational policy and practice. Identifying central organizations in collaborative settings is important because these organizations might be especially integral to coordination efforts by nature of their extensive connections to other organizations in the network. Since information exchange networks were examined, those organizations that emerged as central can be conceptualized in one of three ways depending on the centrality type: (1) as organizations that are well informed about the happenings in the council network due to their extensive connections (i.e., organizations high on degree centrality), (2) as organizations that are either controlling the information available to other organizations or organizations that are bringing information to not well connected organizations (i.e., organizations high on betweenness centrality), or (3) as organizations that will most quickly spread new information in the network (i.e., organizations high on closeness centrality).

Domestic Violence Programs emerged as central actors using all threes criteria of centrality in all but one network. Previous research has found that governmental organizations tend to be central in collaborative initiatives (Mandarano, 2007; Mendel, Damberg, Sorbero, Varda, & Farley, 2009). However, the prominence of Domestic Violence Programs relative to governmental

agencies may be explained by the agenda of FVCs, which is one that Domestic Violence Programs are invested in and might even be driving. Therefore, Domestic Violence Programs are highly involved in the councils and pursue ties in the council and impose themselves as central in the network to drive the council's agenda. This might then position them as change brokers to the extent they are viewed as legitimate players and experts on family violence. So, it might be the agencies that are highly invested in the agenda of the collaborative initiative that emerge as central and prominent players in the setting because of the active role they play in bringing other stakeholders together to respond to specific cases of domestic violence and to build interagency relationships to improve the response to domestic violence cases more generally. This reasoning supports previous research. For example, Mandarano (2007) found that the US EPA was a highly central organization in estuary networks. This may be because the EPA is highly invested in the environmental agenda of the network. The highly invested and central organizations in a setting are the ones that collaborative initiatives should target for coordination efforts, such as access to information and resources, since these are the organizations that have extensive ties to other organizations in the network or are willing to take the time and effort to build those ties if they are not initially present.

While being highly central, Domestic Violence Programs are not the only prominent organizations in councils. Law enforcement agencies are also central and prominent players in FVCs. This finding supports previous research regarding the prominence of

Table 7
Sector as predictor of closeness centrality.

Variable	Model 1			Model 2		
	B	SE B	β	B	SE B	β
Constant	53.722	0.912		56.936	1.495	
Circuit A	8.027	1.834	0.253[**]	8.324	1.792	0.263[**]
Circuit B	−2.742	1.282	−0.138[*]	−2.301	1.260	−0.116
Circuit C	−0.600	1.603	−0.022	−0.329	1.570	−0.012
Circuit D	−6.498	1.237	−0.342[**]	−6.264	1.199	−0.329[**]
Sector 7				6.093	3.633	0.091
Sector 6				−0.801	1.889	−0.029
Sector 5				−3.953	1.889	−0.142[*]
Sector 4				−5.210	1.641	−0.246[**]
Sector 3				−4.165	1.505	−0.238[**]
Sector 2				−10.025	4.050	−0.134[*]
R^2		0.207			0.274	
Change in R^2		0.207[**]			0.067[**]	

Note: N = 296.
[*] $p < .05$.
[**] $p < .01$.

governmental agencies, such as law enforcement agencies, in collaborative settings (Mandarano, 2007; Mendel et al., 2009). This may be due to the access to resources, such as funding, that government agencies have, or it may be due to the necessity of involving government agencies for certain purposes (e.g., legal recourse for family violence). In particular, law enforcement agencies might be central due to their formal role as responders to family violence, and therefore are often the target of systems change efforts. The position of law enforcement as central in a given network of responders may bode well for being able to leverage change because they are viewed as organizational "insiders" by other criminal justice agencies. Their investment and centrality in a given network may suggest that they are poised to be an influential player to advance FVC efforts by bringing along their "peer" agencies (i.e., other law enforcement). Department of Child and Family Services (DCFS) emerged as central using all three criteria of centrality in Circuit D, as well as the DCFS regression coefficient being the only one that was not significant in the sector comparisons with domestic violence in all three regression analyses. Due to the vast size of the circuit (see Table 1), regional organizations, such as DCFS, might be the only organizations that formally serve numerous counties, and therefore are connected to organizations across counties, because their work mandates them to do so.

Perhaps not surprisingly, the centrality of organizations in a given network was related to the perceived influence of council efforts on policy and practice. Degree, betweenness, and closeness centrality were related to peer-ratings of the impact of council efforts on changes in policy and practices. These three measures of centrality were linked to council efforts above and beyond the agency being a member of the council. So, while members of the council might be perceived has having greater shifts in their policy and practices relating to family violence, the extent to which these organizations are centrally connected is also related to their being perceived as influenced by council efforts. This is further indication of centrality being an important attribute of networks because it might not only indicate which organizations to target for coordination efforts but also indicate that having a central position in a network makes organizations more poised for influence by FVC. However, it is important to note that when all three measures of centrality were examined simultaneously, only closeness centrality still predicted outcomes of interest, likely due to the high collinearity between the three centrality indices (see discussion below). This means that closeness (rather than degree or betweenness) may be the "active ingredient" in the centrality findings. That is, the key is not how many contacts an organization has, nor whether it is a bridge between contacts, but rather how close it is to all other members, on average. Conceptually, closeness is the index that would be used to capture how quickly contagious disease spreads from one person to all others in the network, because high closeness means the fewest steps from the focal actor to all other actors in the network. Thus, future research on coordination in FVCs might consider conceptualizing centrality not only in terms of social capital (number of contacts or bridging/brokering), but also in terms of closeness (i.e., the network structural position that suggests quicker access to information from all others in the network, and perhaps quicker influence to all others in the network, on average).

There were certain limitations in this study. First, the study used organization informants' self-report regarding information exchanges with each other. Such self-report might be susceptible to self-presentation bias (i.e., respondents report more ties than actually exist to portray their organizations in a positive light) and assumes that a respondent's memory regarding her or his information exchanges with another organization is accurate. Future studies might use more objective measures of exchanges between organizations (e.g., the presence/absence of memoranda of understanding, joint ventures, and/or resource sharing) and compare those to self-reports of exchanges to see if the same network structure emerges using different types of information. A second limitation in the study is the high correlation between all three centrality indices (see Table 4). Such correlations may indicate that the three might not be separate constructs. All three indices were still included in all analyses because conceptually they represent different phenomenon (i.e., degree centrality represents how vast an organization's direct contacts are, betweenness centrality indicates an organization's potential to be an information broker, and closeness centrality is how closely an organization is linked with others), and therefore the implications for a network and its organizations might be different using the different criteria. However, given the high correlation between the three, future studies interested in examining different measures of centrality in the same networks should look at the correlation between their centrality scores and if they are high, should consider choosing the measure most relevant to their outcome of interest.

Future research should also examine centrality in collaborative networks longitudinally and see if the same organization types remain central as the collaborative matures. For example, organizations that are providing the funding for the collaborative might be more central during its formation. However, once the collaborative has matured, other more direct service or advocacy agencies that are seen as experts in the field might become more central. Such examination could help us further understand if the same organization types remain prominent players in collaborative settings, and therefore are important to target for change efforts.

The current study found that Domestic Violence Programs were most likely to emerge as central in these settings, which implies that organizations that are heavily invested in the agenda of collaborative settings are likely to position themselves as central in the setting to influence other stakeholders. The study also found that those organizations that were highly central were also more likely to be rated as having the greatest shifts in their policy and practices due to council efforts. This implies that organizations that are central are not only situated to influence others in the setting but are more likely to be influenced by the setting due to their extensive connections to other members of the setting. Therefore, this study showed the importance of centrality in collaborative settings as an index of members' potential to influence councils, and also to be influenced by councils. Examining councils in light of the patterns of centrality in their networks may shed light on which organizations are poised to be brokers of change in collaborative efforts.

Conflict of interest

The authors have no conflict of interest to declare.

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