Seeing the forest and the trees: Using network analysis to develop an organizational blueprint of state tobacco control systems

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\textbf{A R T I C L E I N F O}

Article history:
Available online 21 August 2008

Keywords:
Network analysis
Tobacco control
Systems
Organizations
Blockmodeling
Public health

\textbf{A B S T R A C T}

In the United States, tobacco control activities are organized primarily in state tobacco control programs. These programs are comprised of public and private agencies working together to reduce tobacco use. The human, financial, and informational resources that go into state tobacco control programs are documented, and the outcomes of these programs have been studied in terms of health and health behavior. However, little is known about the organizational infrastructure that transforms the human, financial, and informational resources into positive health outcomes. This study examined the inter-organizational relationships among key partner agencies in eight state tobacco control programs. The state programs varied in terms of funding level, funding stability, and region of the country. Using a network analytic approach we asked an average of 14 agencies in each state program about their contacts and partnerships with the other key tobacco control agencies in their state program. Using network visualization and statistics we determined that the state networks shared some common features such as a highly central lead agency, but also had differences in network structure in terms of density and centralization. Using blockmodeling we found that, despite differences in state and program characteristics, there was a common organizational structure among the eight state programs. Understanding the inter-organizational relationships and the common organizational structures of state programs can aid researchers and practitioners in enhancing program capacity and in developing strategies for organizing effective public health systems.

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\textbf{Introduction}

Public health problems such as tobacco use, obesity, and chronic disease, are complex and cannot be solved by a single person or program. Instead, partnerships among people and programs with varied knowledge, skills, and resources are required (\textit{National Cancer Institute, 2007}). These partnerships allow resources and expertise to be shared (\textit{Provan & Milward, 2001}) and may facilitate more efficient and effective provision of public health services (\textit{Alter & Hage, 1993}; \textit{National Cancer Institute, 2007}; \textit{Provan, Harvey, & de Zapien, 2005a}; \textit{Provan, Veazie, Staten, & Teufel-Shone, 2005b}). While the importance of collaborations within public health systems has been recognized (\textit{Leischow & Milstein, 2006}), there is little information about how these systems are structured (\textit{Leischow & Milstein, 2006}; \textit{National Cancer Institute, 2007}; \textit{Provan et al., 2005a}). Recently there have been numerous calls for research into public health system structures (\textit{Leischow & Milstein, 2006}; \textit{Robert Wood Johnson Foundation, 2007}); however, this area of research is still in early stages. Because tobacco control programs are well established, exist in every state, and have been shown to be able to reduce the health burden of tobacco use (\textit{Farrelly, Pechacek, & Chaloupka, 2003}), they may provide useful

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information regarding public health system structure. This study examines the inter-organizational relationships in eight state tobacco control programs.

In the United States, tobacco control activities are organized primarily within state tobacco control programs (Krauss, Mueller, & Luke, 2004), which were typically developed through one of a few national initiatives (Centers for Disease Control and Prevention, 2007; National Cancer Institute, 1995, 2005, 2006; Robert Wood Johnson Foundation, 2006). Each program is a complex system comprised of public and private agencies with the common goal of reducing tobacco use. Overall, programs strive to be comprehensive in their approach to tobacco control, implementing a variety of activities (e.g., counter-marketing, cessation) described in the Centers for Disease Control and Prevention’s (CDC) Best Practices for Comprehensive Tobacco Control Programs (Centers for Disease Control and Prevention, 1999). While they share common backgrounds, goals, and comprehensive strategies, state tobacco control programs have evolved over time to have different funding levels, program focuses, and key partners (Krauss et al., 2004; Mueller, Luke, Herb- ers, & Montgomery, 2006).

Past evaluations and monitoring of tobacco control programs have documented what goes into state tobacco control programs in terms of financial, human, and informational resources. For example, Jones, Austin, Beach, and Altman (2007) described recent allocation of Master Settlement Agreement funds toward tobacco control in North Carolina. In addition, program outcomes such as changing knowledge and behavior around tobacco use have been studied. For example, increased funding for tobacco control is associated with reduced tobacco use among youth (Tauras et al., 2005). However, little is known about the organizational infrastructure of state tobacco control programs. That is, we do not know how partners working in state tobacco control programs collaborate to transform a program’s resources into changes in knowledge and behavior related to tobacco use. In this study we sought to determine what roles and relationships exist among state tobacco control program partners that support this transformation.

Because state tobacco control programs are comprised of organizations working together toward a common goal, a network approach was used. Unlike traditional approaches to evaluation which focus on the attributes of programs or organizations (Sly, Heald, & Ray, 2001), network approaches focus on relationships among organizations (Luke & Harris, 2007; National Cancer Institute, 2007). A few of the characteristics which can be examined using this relational focus include: the overall level of involvement of organizations in a network; types of interactions among organizations in a network; and patterns or structures of organizational involvement in a network. Understanding these types of characteristics allows public health researchers and practitioners to strengthen relationships, build capacity, and reduce duplication of effort (National Cancer Institute, 2006, 2007; Provan et al., 2005b).

In public health, network approaches have been used to examine public health systems addressing issues such as health policy (Provan et al., 2005a), provision of HIV services (Kwait, Valente, & Celentano, 2001), and emergency preparedness (Harris & Clements, 2007). Public health organizational network studies like these typically focus on a single public health system (National Cancer Institute, 2007: 151); this study adds to the literature by examining the underlying structures of multiple public health systems.

Given similar goals, strategies, and backgrounds of state programs, and evidence of similarities in organizational network structure from a previous descriptive study (Krauss et al., 2004), we hypothesized that there were organizational similarities underlying every state tobacco control program. We used network analysis to examine the inter-organizational relationships in eight state tobacco control programs with the goal of developing a blueprint showing these common organizational structures. The purpose of developing this blueprint was threefold: (1) provide new and existing programs with useful information for developing or maintaining organizational networks; (2) begin filling the gap in knowledge about the inter-organizational structure of state tobacco control programs; and (3) add to the literature supporting development of evidence-based recommendations for organizing effective public health systems.

Project description

In 2004 the Center for Tobacco Policy Research conducted an evaluation of eight state tobacco control programs. The cross-sectional study examined the organization and implementation of the programs following unprecedented funding cuts for tobacco control nationwide (National Governors Association and National Association of State Budget Officers, 2003).

Methods

Sample selection and data collection

States were invited to participate based on three program characteristics: (1) funding level, (2) funding stability, and (3) geographic location. Funding level was used as an indicator of program comprehensiveness and was determined by the amount a state spent on tobacco control compared to the CDC recommended minimum (Centers for Disease Control and Prevention, 1999). Funding stability was categorized as critical or threatened. Critical states had experienced a significant (>50%) loss of funding and elimination or reduction of program components. Threatened states were faced with imminent funding cuts, had a small reduction in funding, or had cut funding reinstated. Critical states were Florida, Minnesota, Oregon, and Indiana. Threatened states were Michigan, Nebraska, New Mexico, and North Carolina. States were also selected from a variety of geographic locations to account for different financial and political environments in different regions. Tobacco-related characteristics of the selected states showed important differences such as excise taxes ranging from $0.05/pack in North Carolina to $2.00/pack in Michigan (Table 1).
We used a one-step modified reputational snowball sampling approach (Doreian & Woodard, 1992; Farquharson, 2005) to identify a subset of partner agencies in each state. Initially the program manager from the lead agency in each state compiled a list of partners who contributed substantially to the program or had a unique role. The research team, the lead agency program manager, and the statewide coalition director from each state then reviewed the list and finalized the agencies that would be invited to participate. This strategy resulted in a list that represented the partners in the state but did not include all partners. An average of 18 individuals at 14 agencies in each state participated in a semi-structured interview, for a total of 146 interviews. Interviews were conducted in person (48%) or on the telephone (52%) by trained interview teams. The average interview lasted 64 min.

Types of agencies in state tobacco control programs

The eight programs were comprised of six agency types: (1) lead agencies; (2) contractors and grantees; (3) coalitions; (4) voluntaries and advocacy groups; (5) other state agencies; and (6) advisory and consulting agencies (Table 2). The number of partner agencies of each type varied by state. For example, Minnesota’s network included one other state agency, while Oregon’s network included six. Despite this variety, states showed similar mixes of agency types. Five states included all agency types in their networks; Michigan did not include other state agencies, and New Mexico and North Carolina did not include advisory and consulting agencies.

Network measures

Using traditional network analytic methods (Wasserman & Faust, 1994) we examined inter-organizational contact and integration in each state.

Contact

To determine the frequency of contact among partners, participants were given a roster of key partners in their state and asked how often their organization had contact with each other organization on the roster. The response categories were daily, weekly, monthly, quarterly, yearly, no contact, or don’t know. To aid in structural analysis, the contact measure was dichotomized with a cut-off of quarterly contact. Agencies having contact with each other more than quarterly were considered to have contact, while agencies having contact with each other quarterly or less often were considered to have no contact.

Integration

The integration measure was adapted from the work of Slonim et al. (2007). Participants were asked to choose the response that best described the current relationship between their agency and each of the other agencies on the roster. The response choices and definitions given to participants were as follows:

<table>
<thead>
<tr>
<th>Agency type</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead agency or agencies</td>
<td>Responsible for program coordination and implementation</td>
</tr>
<tr>
<td>Contractors and grantees</td>
<td>Agencies that have been contracted by the lead agency to implement tobacco control activities, provide a service (e.g., media), conduct program evaluation, or other related tasks</td>
</tr>
<tr>
<td>Coalitions</td>
<td>A group of individuals representing two or more organizations working together to address an issue such as tobacco use which they couldn’t address adequately on their own</td>
</tr>
<tr>
<td>Voluntaries and advocacy groups</td>
<td>Agencies that provide programs/activities to the state but are not contractors/grantees (e.g., American Lung Association)</td>
</tr>
<tr>
<td>Other state agencies</td>
<td>Other state government agencies that are an integral part of the tobacco control effort and may include those that are responsible for a specific component of the program (e.g., State Department of Education)</td>
</tr>
<tr>
<td>Advisory and consulting agencies</td>
<td>Executive or advisory boards to the lead agency or the program; provide consulting or technical assistance but are not contractors/grantees</td>
</tr>
</tbody>
</table>

Table 1
Tobacco-related characteristics of the eight states at the time of the evaluation (2004)

<table>
<thead>
<tr>
<th>State</th>
<th>State cigarette excise taxa</th>
<th>% Current smokersb</th>
<th>Tobacco control spending (in millions)c</th>
<th>% of CDC Recommended minimum spendingc</th>
<th>Tobacco growing stated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Florida</td>
<td>$0.34</td>
<td>20.2</td>
<td>$1.8</td>
<td>2.2</td>
<td>Yes</td>
</tr>
<tr>
<td>Michigan</td>
<td>$2.00</td>
<td>23.3</td>
<td>$6.4</td>
<td>11.6</td>
<td>No</td>
</tr>
<tr>
<td>Oregon</td>
<td>$1.18</td>
<td>20.0</td>
<td>$4.5</td>
<td>21.2</td>
<td>No</td>
</tr>
<tr>
<td>Nebraska</td>
<td>$0.64</td>
<td>20.3</td>
<td>$4.2</td>
<td>31.3</td>
<td>No</td>
</tr>
<tr>
<td>Indiana</td>
<td>$0.56</td>
<td>24.9</td>
<td>$12.2</td>
<td>35.1</td>
<td>Yes</td>
</tr>
<tr>
<td>New Mexico</td>
<td>$0.91</td>
<td>20.3</td>
<td>$6.1</td>
<td>44.7</td>
<td>No</td>
</tr>
<tr>
<td>North Carolina</td>
<td>$0.05</td>
<td>23.1</td>
<td>$27.8</td>
<td>65.3</td>
<td>Yes</td>
</tr>
<tr>
<td>Minnesota</td>
<td>$0.48</td>
<td>20.7</td>
<td>$19.9</td>
<td>69.4</td>
<td>No</td>
</tr>
<tr>
<td>U.S. Average</td>
<td>$0.84</td>
<td>20.9</td>
<td>–</td>
<td>39.3</td>
<td></td>
</tr>
</tbody>
</table>


b Centers for Disease Control and Prevention, 2004.


• Not linked or integrated at all – We do not work together at all and have separate program goals
• Communication – We share information only when it is advantageous to either or both programs
• Cooperation – We share information and work together when any opportunity arises
• Coordination – We work side-by-side as separate organizations to achieve common program goals (i.e., efforts are coordinated to prevent overlap but perform tasks as separate organizations)
• Collaboration – We work side-by-side and actively pursue opportunities to work together as an informal team (i.e., attempt to find ways to work together but do not establish a formal agreement or contract, “in the spirit of collaboration”)
• Partnership – Work together as a formal team with specified responsibilities to achieve common program goals (i.e., have formally identified common goals and areas of responsibility for each organization, usually outlined in a Memorandum of Understanding or other agreement)
• Fully linked or integrated – We mutually plan, share staff and/or funding resources and evaluate activities to accomplish our common goals

For analysis purposes integration was dichotomized into not linked or linked. Agencies integrated at a level higher than cooperation were considered linked, while agencies at cooperation or below were considered not linked.

Network data management

In order to conduct analyses at the agency level we collapsed participant responses in two ways. First, where multiple participants were interviewed from the same agency, the mean of the responses was used in the analysis so that each agency was represented once. For example, if we interviewed three participants from agency Y, their responses were averaged into a single set of responses representing agency Y. After averaging responses from the 146 individual participants, we had a set of 110 responses representing the 110 agencies in the study.

Second, we used two strategies to resolve disagreements between pairs of participants. When participant responses were very close, we averaged the two responses. For example, if participant A indicated having contact with participant B on a weekly basis (weekly was scored as 4) and participant B indicated having contact with participant A on a daily basis (daily was scored as 5); we averaged the responses for a contact level of 4.5. If the responses of two participants were very different (e.g., A indicated daily contact with B, but B indicated yearly contact with A), the two partners were called individually and asked to verify their responses.

Eight percent of responses to the contact question and 5.6% of responses to the integration question were missing or “don’t know.” We used reconstruction to address these responses. That is, for any pair of agencies where only one agency provided a response, we used the single response to describe the link between the agencies (Stork & Richards, 1992). For example, if participant A indicated weekly contact with B and participant B did not respond, then the link between A and B was considered to be weekly contact. Reconstruction is currently the accepted method of data imputation for undirected networks. In cases of small amounts of missing data (<30%), reconstruction has been shown to preserve many of the commonly used descriptive network statistics (Huisman, 2007; Stork & Richards, 1992). Where both responses in a dyad were missing or “don’t know,” we assigned a zero value or no relationship between the agencies.

Network analysis

We used Pajek 1.13 (Batagelj & Mrvar, 2007) for network statistics and visualization. This allowed us to compare networks within and across states at agency and network levels. The network statistics calculated focused on the interconnectedness (density) and prominence (centrality) of network members. Because they have been shown to influence how far and how fast information or interventions may spread, density and centrality have been identified as potentially the most informative network measures when examining public health systems (Valente, Chou, & Pentz, 2007). For instance, networks with high density are more interconnected than networks with low density, providing more paths for communication or dissemination of information. Centralized networks have a single or small group of well connected nodes that can disseminate information to many other network members quickly (Valente et al., 2007).

There are several types of centrality and centralization which can be measured (e.g., betweenness, closeness, degree). In this study we selected betweenness in order to measure influence or control over the flow of information in the networks (de Nooy, Mrvar, & Batagelj, 2005). Betweenness is often used in organizational network analysis in order to understand the strategic advantage of network members. There are two types of betweenness: (1) betweenness centrality and (2) betweenness centralization (see Table 3). Betweenness centrality is a node level measure indicating the level of influence a node has in the network. Betweenness centralization is a network level measure indicating how much variation there is in

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Network measure definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network measure</td>
<td>Definition</td>
</tr>
<tr>
<td>Density</td>
<td>The number of connections in a network as a proportion of the maximum possible number of connections (de Nooy et al., 2005). Network density ranges from 0 to 1.0</td>
</tr>
<tr>
<td>Subgroup density</td>
<td>The number of connections in a subgroup of nodes as a proportion of the maximum possible number of connections in the subgroup (Wasserman &amp; Faust, 1994). Subgroup density ranges from 0 to 1.0</td>
</tr>
<tr>
<td>Betweenness centrality</td>
<td>A node level measure indicating the frequency with which a node lies on the shortest path connecting other nodes (Freeman, 1979). For example, if nodes A, B, and C were connected as follows: A → B → C, node B would have high betweenness centrality since it falls along the shortest path between A and C</td>
</tr>
<tr>
<td>Betweenness centralization</td>
<td>A network level measure indicating the variance of the betweenness centralities of all nodes (de Nooy et al., 2005)</td>
</tr>
</tbody>
</table>


betweenness centrality among the nodes (i.e., are most nodes about equally central or are there some that are much more central than others). Because agencies with high betweenness centrality are, by definition, on the shortest path between pairs of unconnected nodes, these agencies act as “gatekeepers” controlling the flow of information between the agencies in the network that are not directly connected to each other. Throughout the remainder of this study, centrality and centralization refer to betweenness centrality and betweenness centralization. Table 3 includes definitions of density, centrality, and centralization.

Results

Network visualization

Fig. 1 shows four of the eight contact networks, while Fig. 2 shows four of the eight integration networks. (Due to space constraints, each state is shown in either Fig. 1 or Fig. 2. Contact the authors for additional network graphics or grayscale versions of the networks.) The nodes in each network represent the tobacco control partners in the state. The color of each node represents agency type (e.g., red nodes represent coalitions). Node size represents centrality; larger nodes are more central. The lines connecting the nodes represent a relationship between the two partners. In the contact network, a line represents contact between partners more than quarterly. In the integration network, a line represents partners integrated at the level of coordination or higher.

Not surprisingly, lead agencies took central roles in all states in both the contact and integration networks. However, the level of centrality of the lead agency differed somewhat across states. For example, there is a clear visual and statistical difference in the centrality of lead agencies in Michigan (lead agency centrality = 0.48) and North Carolina (lead agency centrality = 0.19) (Fig. 2). Centrality scores differed significantly by agency type for both contact \( (F = 16.9; \ P < 0.001; \ \eta^2 = 0.45) \) and integration \( (F = 26.5; \ P < 0.001; \ \eta^2 = 0.56) \). This suggests that different agency types play different roles in the state programs.

Network characteristics of state tobacco control programs

The range of network statistics (Table 4) suggests there are important differences in network structure across states. For example, Florida has the least contact density of the eight states. Getting information to spread across this network could take longer since there are...
fewer communication paths between partners (Valente, 1995). In contrast, the North Carolina contact network has high density, allowing information to spread more quickly.

The differences in centralization among the state programs are also important. Aspects of centralization have been linked to efficiency and participation in a network (Valente et al., 2007). Specifically, centralized networks have central members who can enact decisions and disseminate information and interventions quickly throughout a network (Valente et al., 2007). Of the contact networks, Oregon has the highest level of contact centralization (Table 4). This is shown visually in Fig. 1d, which has a wide range of node sizes (i.e., there is a larger difference in size between the smallest and largest nodes in more centralized networks). In contrast, Minnesota has the lowest level of contact centralization (Table 4), which can be seen in uniformity of node sizes

**Table 4**

Network characteristics of state tobacco control programs

<table>
<thead>
<tr>
<th>State</th>
<th>General Contact (quarterly)</th>
<th>Contact (≥ quarterly)</th>
<th>Integration (≥ coordination)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Density</td>
<td>Centralization</td>
<td>Density</td>
</tr>
<tr>
<td>Florida</td>
<td>0.23</td>
<td>0.29</td>
<td>0.30</td>
</tr>
<tr>
<td>Michigan</td>
<td>0.49</td>
<td>0.20</td>
<td>0.37</td>
</tr>
<tr>
<td>Oregon</td>
<td>0.37</td>
<td>0.44</td>
<td>0.39</td>
</tr>
<tr>
<td>Nebraska</td>
<td>0.48</td>
<td>0.18</td>
<td>0.45</td>
</tr>
<tr>
<td>Indiana</td>
<td>0.48</td>
<td>0.30</td>
<td>0.53</td>
</tr>
<tr>
<td>New Mexico</td>
<td>0.62</td>
<td>0.19</td>
<td>0.56</td>
</tr>
<tr>
<td>North Carolina</td>
<td>0.64</td>
<td>0.13</td>
<td>0.59</td>
</tr>
<tr>
<td>Minnesota</td>
<td>0.56</td>
<td>0.13</td>
<td>0.48</td>
</tr>
</tbody>
</table>
in Fig. 1b. As far as integration, Florida and Michigan have the highest centralization (Table 4, Fig. 2a, b), which is shown by the wide range of node sizes in these networks.

State tobacco control program blueprint

Despite providing information on similarities and differences among the networks, the network measures and graphics do not provide much insight into patterns of connections among agencies. To determine if there was an underlying common organizational structure across the state programs we used a network analytic technique called blockmodeling (Doreian, Batagelj, & Ferligoi, 2005). Blockmodeling permits a description of network structure based on the identification of underlying positions (Wasserman & Faust, 1994). A position contains nodes which relate to other nodes in similar ways. For example, a typical university department contains administrative positions, faculty positions, and student positions. The interactions between these positions are likely to be different; faculty members interact with students regularly, however, students interact rarely with administration. Positions can be defined or specified in a number of different ways including by characteristics of the nodes or characteristics of the links (Wasserman & Faust, 1994). In this case we defined positions by a node characteristic: agency type. We then developed a blockmodel for each state based on the level of connectedness between agency types (e.g., out of all possible connections between advisory agencies and contractors/grantees, how many connections exist).

The relationships between positions are shown in the image matrices in Fig. 3. Image matrices are graphic representations of a network using shaded rectangles to show connectedness between network positions (de Nooy et al., 2005). In this figure, the shading shows the connectedness between network positions for contact. A white or light gray block indicates little contact between the agency type in the row and the agency type in the column. For example, in the Oregon network notice the light gray in the other state agency row (row 5) for the contractor/grantee column (column 2). In Oregon, there is little contact between other state agencies and contractors/grantees. A darker gray or black block indicates high connectedness, or more contact between the row and column agency types. For example, see the Nebraska matrix coalition row (row 3) and contractor/grantee column (column 2). This square is dark gray indicating high contact between coalitions and contractor/grantee agencies in this program.

Note a few of the similarities among the matrices across the states: there is high contact between the lead agency (row 1) and all other agency types, high contact between coalitions (row 3) and voluntary/advocacy agencies (column 4), and moderate contact between the contractor/grantee agencies (row 2) and coalitions (column 3). Florida appears to be an exception to many of the patterns seen among the states. This is a reflection of the lack of contact between agencies in the Florida program; Florida had less than half the density of contact of most states in the sample.

By aggregating the blockmodel image matrices across states, we developed a common blueprint of contact and integration within state tobacco control programs. Where the matrices showed a high level of connectedness (subgroup density > 0.50) between two agency types we included a connection between the two agency types. When connectedness was less than 0.50 we did not include a connection between the agency types. In other words, if at least half of the possible links between two agency types existed, the blueprint shows a link. Fig. 4 shows the contact and integration blueprints for the eight state programs. On the left in this figure are the aggregated matrices (Fig. 4a, c); while on the right are the blueprint networks (Fig. 4b, d).

Each link and black square in these two graphics represents regular contact or integration of the two agency types. For example, in the contact blueprint there is a link between coalition and voluntary/advocacy. This indicates that there is typically regular contact between coalitions and voluntary/advisory agencies in state tobacco control programs. This is confirmed by Fig. 3, which shows high

![Fig. 3. Shaded image matrices representing regular contact between agency types in eight state tobacco control programs. (*MI network did not include other state agencies; NC and NM networks did not include advisory/consulting agencies.)](image-url)
patterns of contact and integration among the partnering agencies. Although the networks varied from state to state, we found that agencies of different types played similar roles across all states. We developed blueprints based on these similarities which identified common organizational structures.

The blueprints included several structural features important to understanding state tobacco control programs. First, state programs included similar mixes of six agency types with consistent types of working relationships among them. Second, patterns of contact and integration among partners showed star structures with the lead agency connected to all agency types. Third, there were connections between coalitions and voluntary/advocacy groups in both blueprints; these connections may be important to programs in facilitating activities, such as advocacy, that cannot be undertaken by lead agencies in state health departments.

These findings may be useful to new and existing state tobacco control programs. For example, in order to ensure a new program can address the best practices areas (Centers for Disease Control and Prevention, 1999; National Cancer Institute, 2006), the lead agency could seek opportunities for contact and integration with agencies representing every agency type. Furthermore, our results suggest that regular contact and integration between statewide coalitions and the various voluntary agencies (e.g., American Lung Association) may be important indicators of program functioning.

In addition, existing programs faced with changing funding and political climates may use the blueprints in strategic planning efforts. For example, in the case of a significant cut in funding, such as the $37 million cuts in Florida in 2002–2003, the lead agency may plan to sustain at least one connection to an agency of each type. In this way the lead agency would maintain a statewide network that included expertise in many areas. However, even with a common blueprint, program inputs will continue to vary, as will program structures and outcomes.

In addition to giving new insight into state tobacco control systems, the blueprints developed in this study may provide public health systems in other areas information useful in developing inter-organizational partnerships. Inter-organizational collaboration among public health agencies facilitates the sharing of resources and expertise (Provan & Milward, 2001) and may lead to more efficient and effective provision of public health services (Alter & Hage, 1993; National Cancer Institute, 2007; Provan et al., 2005a, 2005b). Despite these important functions of collaboration in public health systems, there has been little to guide public health programs in determining who to partner with and what kinds of partnerships to develop (Harris & Clements, 2007; Provan et al., 2005b). This study is an example of the types of partnerships comprising public health systems in an area (tobacco control) that is well established and has had some success.

**Limitations**

The main limitations are sample size and sampling strategy. Within each state, our sample was not exhaustive...
of all tobacco control partners. We did not set a strict limit on the number of partners a lead agency could identify; however, we asked the lead agency to include only key partners. However, based on the inclusion of the same six types of agencies across the states, the networks appear to include an accurate representation of constituent agencies. In addition, this evaluation included more agency partners per state than similar multistate evaluations (see National Cancer Institute, 2006).

The sampling strategy may also limit the interpretation of some results, especially with respect to the central role of the lead agency. Because we relied on the lead agency in each state to identify key partners it is logical that we found the lead agency central. However, given the role of lead agencies in state programs (Table 2), it is probable that the lead agency would play a central role regardless of the sampling strategy. In addition, we confirmed the list of key partners with a statewide coalition in each state. Also, despite the lead agency role in identifying partners, not every partner was linked to the lead agency in the final networks (e.g., see Florida, Michigan, Minnesota, and Nebraska in Fig. 3). Finally, similar strategies for identifying organizational network partners have been used in past public health research (Kwait et al., 2001; Woodard & Doreian, 1994).

Future directions

Despite identifying inter-organizational relationships as an important factor in the capacity of tobacco control programs (National Cancer Institute, 2006, 2007), network approaches to examining tobacco control systems have only recently been utilized, and are still primarily a descriptive tool (Luke & Harris, 2007). However, outside of public health, network approaches have been useful in identifying organizational structures that enhance the effectiveness of systems or system members. For example, in business, researchers found that organizations and individuals were in a better position to profit from their interactions with others if they provided a path between others who were not directly connected (Burt, 1995; Kilduff & Tsai, 2003).

Since public health systems are unlikely to be comprised of agencies competing with each other, it is more likely that public health systems will strive to incorporate organizational structures which increase the effectiveness of a system as a whole. For example, a recent review of studies of coalition building found that increased member participation, diversity, collaboration, and group cohesion were associated with increased coalition effectiveness (Zakocs & Edwards, 2006). Another recent study found that reduced network density was associated with the adoption of evidence-based practices in community coalitions (Valente et al., 2007). These findings, along with the current study, add to the understanding of how inter-organizational relationships influence the capacity of tobacco control programs (National Cancer Institute, 2006) and provide information to aid in the development of recommendations for organizing effective public health systems. Ultimately, future studies will need to more directly examine the link between different patterns of inter-organizational structures and program outcomes to determine what types of structures produce the best outcomes.

Conclusion

State tobacco control programs look quite different at first glance; each state program appears to have quite different collections of partner agencies and different patterns of communication and partnerships among the agencies. However, we have shown that by stepping back and analyzing these patterns using network analysis, that the programs have common organizational structures when it comes to contact and integration among key partners. By identifying differences from state to state, and similarities across states, we have described state tobacco control systems in terms of both the forest and the trees.

Acknowledgments

This research was supported by funding from the Association of State and Territorial Chronic Disease Directors (CDD) and the American Legacy Foundation (Legacy) with scientific and technical assistance from the Centers for Disease Control and Prevention Office on Smoking and Health. This manuscript does not necessarily represent the views of CDD or Legacy, their respective staff, or their respective boards of directors.

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