For a Few Dollars More: The Case for Cross-Jurisdictional Sharing in Ohio's Local Health Departments

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DISSERTATION
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This dissertation is dedicated to my wife, Alycia, and my children, Benjamin and Nicholas, whose laughter and support has kept me sane for the past five years.

And to my uncle Charles “Duke” Orcena, whom we lost in 2014 to cancer while I was preparing my dissertation.

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LIST OF ABBREVIATIONS AND TERMS

AFR	Annual Financial Report. A mandatory report to the Ohio Department of Health by LHDs regarding revenue and expenditures; staffing; and structure of LHDs
AOHC	Association of Ohio Health Commissioners. The state association of city/ county health officers. Memberships hovers around 121 of the possible 125 health commissioners (officers)
Clinical Service	LHD services, typically consider medical/ nursing, that provide direct care such as STD testing & treatment, maternal child health services, WIC, etc.
Core Services	A subset of programmatic activities that all LHDs provide [or assure are provided] within a jurisdiction. In Ohio, the *Futures* report outlines these activities.
Cross Jurisdictional Sharing (CJS)	A process by which two or more LHDs engage in both formal and informal relationships for the delivery of public health service while still retaining jurisdictional autonomy
EPHS	EPHS Essential Public Health Service, based on the 10 Essential Services adopted by NACCHO
Foundational Capabilities	A subset of non-programmatic activities that all health departments should have the capacity to conduct such as legal analysis, quality assurance, etc. In Ohio, the *Futures* report outlines these activities.
Health Commissioner (LHO)	AKA Health Officers or LHO. In Ohio, the CEO of a local health department and the chief health officer for a jurisdiction. If not a physician, then an LHD also employs a separate medical director.
IOM	National Academies of Science's Institute of Medicine
LHD	Local health department (also known as local governmental health agency) – an administrative or service unit of local or state government, concerned with health, and carrying some responsibility for the health of a jurisdiction smaller than the state. In Ohio, an LHD is a separate political unit of the state unaffiliated with both the State Department of Health and local county/ city government.

LIST OF ABBREVIATIONS AND TERMS

Minimum Package	Minimum Package of Public Health Services is a model in which a certain level of service is guaranteed for an entire population. Typically construed to be the services that LHDs should assure are provided within a jurisdiction. The concept is advanced in the 2012 IOM report on the status of the Public Health system.
NACCHO	NACCHO National Association of County and City Health Officials
Organizational (Social) Network Analysis (SNA)	Organizational (Social) network analysis (ONA) is the analysis of social networks in terms of network theory, consisting of nodes (representing individual actors/ organizations within the network) and ties (which represent relationships between the individuals, such as resource sharing, information exchange, etc.).
PARTNER (Partner® .net)	A free, Robert Wood Johnson sponsored organizational (social) network analysis tool designed to measure and monitor collaboration among people/organizations.
Personal health services	Personal health services are individual-focused interventions that detect/ treat health conditions. Often used synonymously with clinical services.
Population-based services	Services that protect and promote healthy conditions and the health for *the entire population. A key component of Core Services*
LPHS	Local public health system- Individuals and public and private entities that are engaged in activities that affect the public's health
Public Health *Futures*	White paper issued by the Association of Ohio Health Commissioners on reforming local public health. Term is synonymous with the recommendations and legislative effort that followed.

ABSTRACT

With the 2012 Institute of Medicine's report on the status of public health, the concept of universal menu of core services to be delivered by local governmental public health has been firmly ensconced in the imaginations of practitioners, researchers, and policy advocates. Close to heel has been the ever present shadow of funding and the cost of delivery for not just local public health but local government. This study attempted to examine in detail the impact of network relationships on the cost of delivering core services in Ohio's 125 local health departments.

The growing debate on the value of cross jurisdiction sharing, consolidation, and regionalization as it pertains to the cost of delivering services, the capacity to deliver, and the effectiveness of those services was examined among Ohio's 125 LHDs using social network analysis. Using PARTNER, an online SNA tool, Ohio's local health officers were surveyed to determine the nature of the organizational networks that local health departments have formed to provide core services or meet legal and financial obligations.

The LHD network displayed a high degree of centralization (62.2%) indicating a network with several key, interconnected members and the majority of members having fewer relationships within the network. Twenty-six (26) LHDs had a degree centrality > 10 though the mean was 7.14, representing central actors within the network. The most common programs shared by LHDs were Emergency Preparedness and Epidemiology followed by Clinical Services.

The results of the social network analysis were added to a regression model developed by Bernet and Singh (2013) using data from the National Association of City/County Health Officials on agency performance and demographics as well as performance and financial data from the Ohio Department of Health provided by local health departments to study the influence of CJS on local health department performance and cost to deliver core services.

A linear regression demonstrated that increasing levels of network interaction were associated with an increase in the cost of delivering core services. Closeness Centrality and Value (of network) was also included in the Core Plus-Scale model created by Bernet and Singh in 2013. The addition of Closeness Centrality and Value caused a significant increase in the adjusted R^2 of the entire model.

I. Background and Problem Statement

A combination of factors influences the ability of local governmental public health to successfully meet national standards. While the financing of local public health continues to be kicked down the proverbial road, many studies have linked population size, breadth of service, and ability to meet standards to the cost of delivery. However, many characteristics of the production process including the role of Cross-Jurisdictional Sharing in the delivery of local services have yet to be studied. In order to capture this valuable data point, it was necessary to conduct a systematic network analysis of the local health departments' inter-organizational, peer relationships and to then draw those data points into the more traditional regression analysis for consideration.

Ia. Background and Context

There appears to be a growing, national, concern regarding the efficiency, and by extension the performance, of local public health services. In Ohio, this concern is most often expressed in efforts to consolidate or regionalize governmental public health agencies. The emphasis on 'down-sizing' of political subdivisions ignores the impact and power of cross-jurisdictional sharing (CJS). When properly applied and deliberate, CJS balances the benefits of "mid-sizing" (avoiding consolidation that is either too small or too large) and retaining local control over the majority of decisions, which is the key benefit of local public health (Kaufman, 2010). As with the private sector, the context of the network's market factors (population demographics, sponsors, competition) can help to understand pressures driving the collaboration (Fonner, 1998) and guide research into the impact of networks on the delivery of local public health services.

Either deliberately or coincidentally, the growth of the efficiency movement has paralleled the growth of the standards movements. With the birth of the Public Health Accreditation Board (PHAB), the standards movement has secured a permanent beachhead in the national public health consciousness. Though the link between the new PHAB standards and outcomes has yet to be established, PHAB stands poised to fill the gap for governmental public health that The Joint Commission (TJC) fills for health care systems. Already, policy makers, boards of health, and health officers are using the national public health standards as the performance benchmark of choice.

While health officers struggle with meeting these new national standards, the historic issues of local public health, i.e. funding levels, funding silos, etc., continue to grow or even increase. The National Association of City and County Health Officials reported severe funding cuts and resulting layoffs during the multi-year recession that shadowed the end of the Bush administration and continued

into the Obama administration (NACCHO, 2013). While many LHDs are already heavily involved in cross-jurisdictional relationships, the new expectations have begun to drive further discussion. A recent survey by the Association of Ohio Health Commissioners found that 66% of local health departments were already engaged in Cross-Jurisdictional Services (CJS) (AOHC, 2012). Of both those already engaged in CJS and those who were not, 70% expressed interested in further discussions about CJS. While the rate of shared services varied by type of jurisdiction-- city vs. county-- the preponderance of both categories identified current or desire to share services. This desire does not always reflect elected leadership however. Health Officers struggling to provide services see a need for expanded partnerships, even across jurisdictional boundaries, as a way to increase delivery of programs while elected officials, county commissioners in particular, view shared services as a loss of local control (Felton and Golbeck, 2011).

Unfortunately, many policy makers see regionalization as a desirable goal in order to eliminate 'excess' local government and increase efficiency in the provision of services. A recent effort in Ohio known as Public Health *Futures* highlighted this discussion.

Ohio's Public Health Futures

In the fall of 2011, the Association of Ohio Health Commissioners (AOHC) formed a committee tasked with building consensus within its membership around the modernization of Ohio's local public health system including financing, structure, and core services. This effort was in direct response to a desire by the Governor's Office of Health Transformation to reform the local system. It was the hope of the AOHC that the preemptive action would establish the frames by which any reform would take place. Two key findings drew criticism and praise in alternating waves. The first finding was that all LHDs should become eligible for accreditation and the second, that many smaller LHDs or multiple LHDs in a single county should consider consolidation. This was illustrated in a flow chart outlining the conditions in which an LHD should consider increased cross-jurisdictional sharing (partnerships), consolidation, or even regionalization. While CJS recognizes the sovereignty of each LHD, both consolidation and regionalization focus on the elimination of an LHD in order to achieve a reduction in units of government. With their emphasis on elimination rather than service provision, it is no surprise that both discussions of consolidation and regionalization are often contentious. Unfortunately research has shown greater and greater emphasis on economies of scale being achieved at jurisdiction populations greater than more than 50% of the existing LHDs in the country. The final *Futures* report was issued in June of 2012 and focused on Santerre's (2009) Minimum Efficient Scale, or MES, of 100,000 population (further discussed below).

In 2012, AOHC findings were echoed by the Institute of Medicine (IOM) report, *For the Public's Health: Investing for a Healthier Future*. Both the IOM report and the *Futures* report came to a similar

conclusion: the public health financing system continues to be "profoundly misaligned" for health service delivery. IOM's conclusion was there is "1) insufficient funding for public health and 2) dysfunction in how the public health infrastructure is funded, organized, and equipped to use its funding." The result is an inability of local health departments to equitably serve all communities with core services.

While unsolicited reports such as *Futures* can generate media and grass-root support, policy makers approach these issues with a multitude of considerations that are not rooted in the science or framework of the report. Indeed, the review of privately generated study may be nothing more than a checklist for already held ideas and support of policies the legislature has based on existing relationships and lobbying efforts. Within this paradigm, the politician does not review the research for insight so much as use it-- or manipulate it-- to fit within their existing frame or schema (Lakoff, 2004). This decidedly Machiavellian approach finds support in research by Haynes et. al (2011) who suggest that not only do researchers fulfill different roles for policy makers depending on the agenda at hand, but that politicians and civil servants view the researchers in differing light: one as a foil to be trotted out for conceptual or rhetorical use and the latter for problem-solving and interactive dialogue. In their schema, researchers are used in one of four ways: as a galvanizer to bolster support for an idea, to provide clarity and advice on a course of action, to persuade, or to defend. Running through each of these concepts is the use of the researcher, not the research. In their study the value came from a researcher who could respond to the issue at hand, hence the policy maker's use of a researcher in an active manner is more valuable than a passive research report.

So it was with the Ohio legislature and administration when they focused a narrow beam on the regionalization and Minimum Efficient Scale aspects of the *Futures* report. The ensuing legislative effort in the biannual budget bill focused almost exclusively on the activities that would manifestly or latently result in the consolidation of smaller health districts. Testimony by many small health districts focused on their relative inability to meet the stiff financial demands necessary to meet accreditation. It may have been this more than any other factor that transformed accreditation into a tool in the consolidation quiver. By the end of the legislative process, accreditation was generally used as a proxy for consolidation by the legislative committee and administration (Orcena, 2012). Ultimately, the State of Ohio's chief health official sponsored a series of recommendations that focused on regionalization of grants, consolidation of local health departments, and expansion of shared services without addressing the disjointed and siloed funding of local public health.

Whether these discussions would be occurring in the absence of financial turbulence in the public health stream is unknown. Suffice that governmental financial concerns are the hallmarks of modern US politics and so the discussions are occurring, exacerbated by the new national standards. Many Ohio policy makers have described these new expectations and the potential for consolidation in business terms

(Legislative *Futures* Subcommittee minutes, August 2012). Market forces often dictate the elimination of some businesses in favor of growth in others. During each financial crisis, we can see the resulting turmoil and cannibalization of irresolute companies by their competition. Policy makers in Ohio have contrasted such private sector activity to the 'safety' of public sector agencies

However, the issue of consolidation in local government and public health agencies in particular carries with it certain assumptions for health officers, public health staff, the public, and policy makers. These assumptions drive both the urge to consolidate and the resistance to consolidation. In lieu of consolidation, many LHDs are moving towards expanding cross-jurisdictional sharing or partnerships. *These CJS relationships allow smaller LHDs to provide services while minimizing costs and without the need to consolidate*. In this way, CJS is seen as a bulwark against the need for consolidation, effectively retaining local autonomy while increasing the capacity of an LHD to deliver services (Provan & Milward, 2001; Gray & Wood, 1991).

A 2011 Robert Wood Johnson environmental scan by Libbey and Miyahara examined the many challenges and barriers influencing relationships between LHDs (2011). The foremost conclusion of their work was that the term 'regionalization' was a misnomer as it applied to LHDs. While regionalization carries a strong, defined meaning for public sector agencies, it fails to speak to the breadth of scope of the relationships between LHDs. For public sector agencies regionalization means the loss of local control, the disconnect of services and the served, and the dissolution of a local agency. The researchers found that a gap existed between an intellectual understanding of local public health and the practice of local public health as it relates to the concepts of core functions and essential services among practitioners. This is further complicated by a lack of common language and frame of reference for discussing cross-jurisdictional sharing. MOU and mutual aid agreements, purchased services, shared services, are not unilaterally understood. The number of terms matched the variety of ways that the shared services occurred. Regionalization did not always result in improved capacity or performance but shared service often does. The growth of standardized performance standards, financial austerity, and the prioritization of programmatic CJS were all identified as significant issues for regionalization.

Libbey and Miyahara (2011) also found that clarity of purpose, financial incentives, mutual desire, attention to the complexity of environment including culture and history all were critical to successful partnerships. This speaks to why many regionalization efforts fail to enhance performance or improve efficiency. The key of local health departments is the 'local'. The agency is a product of its environment and depends on a complex network of relationships to effectively provide public health service whether it is enforcement of the food code or building access to primary health care; the history, culture and relationships of the local are key considerations for success. Regionalization eliminates immediately or over time the shared history of a community and a local health department. Conversely,

CJS allows the local health department to maintain its connection and bring additional elements, such as services and expertise, to its program offerings.

Role of Jurisdiction Size

Recent work by Santerre (2009) suggests that a Minimum Efficient Scale exists in respect to local health departments. A regression analysis using data collected by the National Profile of Local Public Health Agencies, found that per capita public health spending decreases as the population reaches approximately 100,000 covered lives. While this increase is not directly proportional, the elasticity of the populations to cost was, 'significant and robust across all three specifications'. Beyond the 100,000 population, the decrease in cost diminishes and dwindles to the point of no further cost saving. In the study, Santerre controlled for the type of services provided and the size/ classification of the LHD in regards to population served. This phenomenon is similar to that experienced by large hospital systems whose relationship of per capita costs to population served resembles an L-shape as the size of the hospital system grows (Finkler, 1979). While Santerre's study did not account for diminishing quality of service, Mays et al.. (2004) investigation into population size and performance found that capacity for fulfilling the 10 essential public health services did not begin to diminish until populations reached 500,000. The two studies leave an impression that public health services are best provided in population 'chunks' between 100K and 500K, a so-called "sweet-spot" for service delivery where performance is balanced against cost.

However, further investigation by Bernet & Singh (2013) using Annual Financial Reporting data in Ohio did not find the L-shaped relationship discovered by Santerre (2009). Instead, Bernet & Singh reported the relationship between per capita expense and population in Ohio was linear, thus refuting for Ohio the belief that consolidations of districts is inherently desirable in order to reduce the cost of LHD services. Bernet & Singh posited that:

> "One possible explanation for the tightness of this relationship draws on simple economics: In highly competitive markets (or in this case resource poor), most firms adopt similar practices and operate with similar efficiency. Increasing budget constraints may have pushed all districts down toward that efficiency frontier".

In addition to the linear relationship between cost and population, the Ohio study found that providing a broader range of services was generally associated with higher resource use and the data suggested a possible 'spill over' between cost to provide clinical services and spending on core services.

The Ohio model went to great lengths to distinguish between core services and clinical services, or optional services. The final model identified four key influencers on per capita spending:

- Higher population is associated with higher resource use.

- City agencies are associated with lower resource use than County agencies.
- Areas with more non-whites and more uninsured are associated with higher resource use. Those with more non-English speakers tend to have lower resource use.
- Rural areas are associated with higher resource use. Rural LHDs almost always incur higher costs to provide core services to a given population (likely as a result of lower population density)

This notion that consolidation is not a natural 'fix' to the funding of Ohio's public health was further supported by a recent report by Stefanek et al.. (2013) that examined 17 of the 20 consolidations of LHDs in Ohio since 2001. Using a blend of statistical analyses of both administrative data primarily drawn from the Annual Financial Report, a mandatory reporting of local health departments to the state of all programmatic expenses and agency demographics, and interviews of senior officials the authors found that while the majority of respondents believed consolidation was a good idea it did not necessarily result in an immediate cost savings to the localities involved.

Taken together, these findings immediately raise several questions in regards to the delivery of local public health services. If, as Bernet & Singh (2013) suggest~~s~~, there is no bending of the cost curve for core services as population grows and as Stefanek et al.. found there is no savings in consolidation then what additional forces are at work? Why has Ohio not experienced the L-shaped curve expected in health care systems (Finkler, 1979) or the decline in spending as described by Bates and Santerre (2008)?

The answer may lie within the structure of Ohio's public health system. To quote Granovetter (2005), "economic models cannot ignore the influence of social interaction/networks." As a decentralized system of local boards of health, the provision of public health services is almost exclusively governed and funded locally. Non-local sources of funds are almost exclusively the result of federal pass through funds with specific purposes and limited reach across the system (AOHC *Futures*, 2012). Only 22% of local public health funding flows through the state including all federal pass through and direct state support; of that only one quarter is from state general revenue (AOHC *Futures*, 2012). The conclusion of the *Futures* report was that Ohio's funding scheme for local public health was considerably misaligned with, "the services that LHDs are mandated and expected to provide".

Given limitations set forth in practice and statute, funding of environmental health locally is primarily fee driven. The limited amount of locally generated discretionary funding is then allocated towards administration and supporting discretionary programs. Due to the competitive nature of many grants and the inability of LHDs to maintain professional staff on part-time basis, many have entered into a vast array of formal and informal relationships with their peers to provide public health services in their jurisdictions. While many of these programs fall into the discretionary or 'other services' (such as sexual health clinics), several are identified as being either a core or foundational service. These jurisdictions are

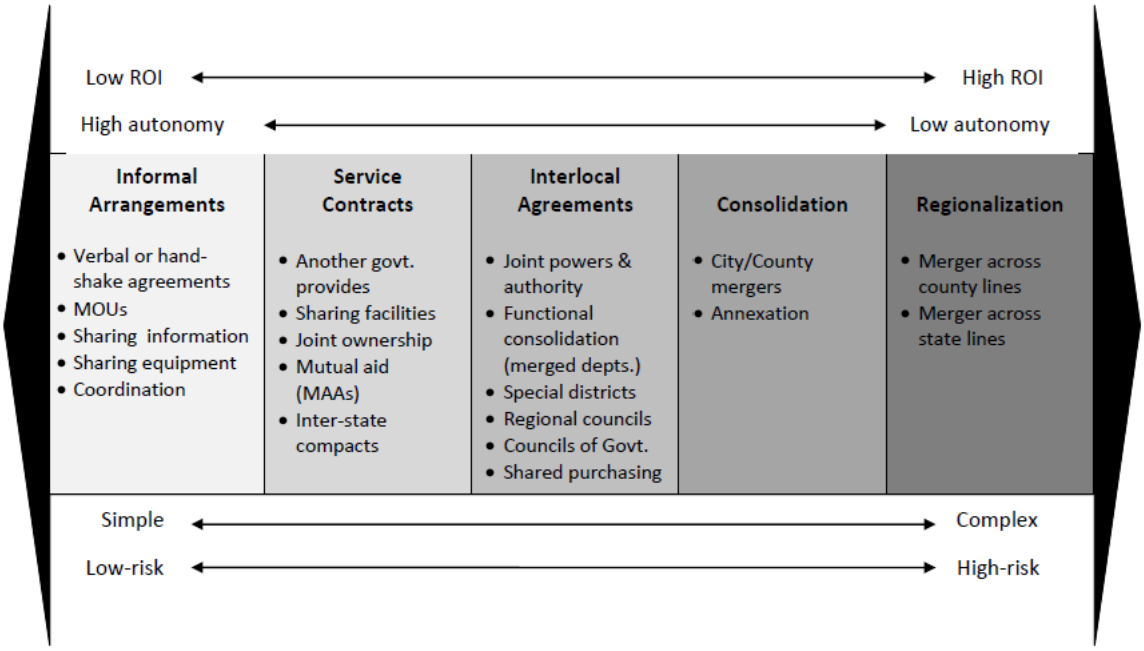
forming inter-organizational networks to improve efficiency and control cost as the private sector is wont to do (Chisolm, 1994). In these networks, specializations, programs, and resources are shared across organizations in order to create economies of scale to avoid failing to provide a service or over-resourcing a program.

Meeting Core Services

Core services are those services identified by the *Futures* report and later adopted by the legislative subcommittee as being a required component of public health services delivered to every locale within the state. Foundational services are those capacities that a local health department should have competency in order to effectively deliver its core services. (see Appendix A). This approach is very similar to the approach taken by the state of Washington in its own efforts to remodel public health services ([Washington State] Public Health Improvement Partnership, 2013) with a similar emphasis on the notion of guaranteeing a minimum or floor of public health services that all residents receive. In the reports own words:

> "The emphasis is on population-based services that are unlikely to get done unless governmental public health does them. A minimum level of funding, outside of categorical funding sources, is needed to ensure that every resident in Washington lives in a community where the governmental public health system can deliver an essential, minimal level of communicable disease control, chronic disease and injury prevention, environmental public health, maternal/child/family health, access or linkage to clinical health care, and vital records."

Given all these concerns and demands, it comes as no surprise that 2 out of 3 LHDs in Ohio report being in a cross-jurisdictional sharing arrangement for the delivery of services (AOHC *Futures*, 2013). Kaufman (2010) suggests that cross-jurisdictional sharing is often instigated by desires to improve quality, access, or expansion of services—in addition to reducing costs. While she did not find accreditation a factor in considering consolidation, accreditation emphasis on performance and quality certainly create the potential for CJS. As with Libbey and Miyahara (2011), Kaufman found that, at the beginning of the conversation, local health departments were unwilling to consider regionalization as a viable means to improve service delivery or reduce expenses. However, CJS is not limited to a single type of relationship but a continuum driven by the services being shared and the formality of the relationship with consolidation and then regionalization at one end. The development of a network-- rather than regionalizing—allows for more efficient use of resources, better coordination, increased capacity, and growth of social capital (Stoto, 2008). As the CJS becomes more complex, the complexity breeds more formality, more risk and potentially more benefits. Figure 1 is Kaufman's (2010) graphic representation of this continuum.



Adapted from: Ruggini, J. (2006); Holdsworth, A. (2006)

Figure 1. Government Shared Services Continuum from Kaufman's 2010 RWJ Study

When simply sharing fails to address the needs of a community either politically or financially, local health departments have opted to consolidate. The earliest reorganizations of public health nationally has been the merging of city and county health jurisdictions with the expectation of a better provision in standard service and better operating economies (Shonick & Price, 1977). Since 1919 in Ohio, the number of independent local health departments has dropped steadily from 180 to 125 political units through voluntary mergers of city and county health districts or contracts for service. In the latter, a typically larger health district assuming responsibility for a city's public health services for a fee. However, the complexity of regionalizing beyond the geographic borders of Ohio's 88 counties makes consolidation an unappealing prospect for any but the remaining city-county possible mergers. In lieu of regionalization, many LHDs have opted for CJS farther to the left of Kaufman's continuum and it is these various intersecting relationships and their impact on funding of local public health service that is the purpose of this research proposal. While local health departments enter in relationships with a myriad of entities, the focus of this work is on the CJS that LHDs engage in among other units of local governmental public health.

Ib. Conceptual Foundation

While Libbey and Miyahara (2011) identified the difficulties with defining 'regionalization', cross-jurisdictional sharing (CJS) can be easily framed within the inter-organization, or organizational, network definition proposed by Chisholm (1998, xxi) which purposes that a network can be defined as, "a set of autonomous organizations that come together to reach goals that none of them can reach separately". While large local health department are structurally equipped to meet performance standards with specialized staffing and resources, small and medium. sized jurisdictions (less than 100,000) rarely maintain the specialized staffing roles required by these standards. In fact, as noted above small jurisdictions attempting to compete with larger jurisdictions are at a structural disadvantage as discovered by Santerre (2009) who suggested that the Minimum Efficient Scale for local health departments occurs around 100,000 population. However, they can find common purpose with their peers and may engage in a complex, voluntary network of relationships to meet standards that individually they would fail to do. These functional networks vary in purpose and size but have tremendous influence on the ability of smaller districts to meet standards.

For the purpose of this study proposal, a functional, inter-organizational public health network, seen through the lens of social network analysis, is an organizational structure made up of organizations called "nodes", which are tied (connected) by one or more specific types of interdependent relationships such as the exchange or provision of finances, services or knowledge (Wasserman, 1994; McPherson et al.., 2001). For local health departments, these can be construed to include expertise specific to public health such as epidemiology, clinical services, or plumbing inspections. These public health networks can be characterized by their purpose--strategic orientation, functional, or structural (Mays et al., 1998)-- or their activities--service delivery, administration, planning (Boland and Wilson, 1994).

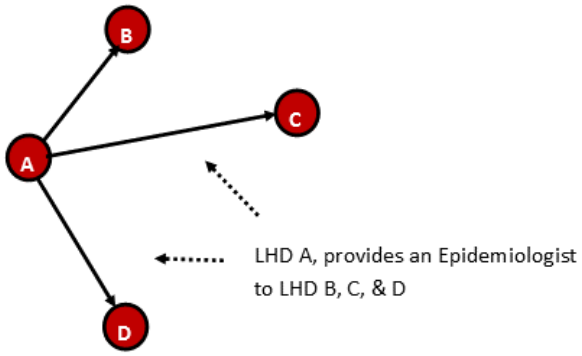


Figure 2. Sample LHD Organizational Network

These networks, or 'collaborative alliances', improve the resilience of organizations by improving efficiencies, sharing resources, containing costs all while preserving organizational autonomy (Gray and Wood, 1991:3)

While many LHDs are currently involved in a variety of network relationships, these networks have the capacity to evolve and have likely evolved (Mays et al., 1998). In the Mays et al. (1998) study, service delivery was the most common functional activity and usually involved hospitals, community health centers, managed care plans, and local health departments. Other activities included surveillance and outreach. In a study by Varda et al. (2008) three types of partners appeared to dominate public health collaborations: community-based organizations; direct service healthcare providers; and colleges/universities (includes medical schools and schools of public health). While the business sector was absent, it was noted that many participants in these collaborations would like to see an increase in representation by the business sector.

With the growing emphasis on national accreditation, the ability of small to medium health districts to meet these standards will only be met through the expansion of collaborative networks if cost per capita is going to remain controlled. Mays et al. (2004) investigation into population size found that capacity for fulfilling the 10 essential public health services did not begin to diminish until populations reached 500,000. Certainly performance is critical to public health officials, so efficiency must be balanced with some measure of performance linked to health outcomes, such as national accreditation standards.

If a Minimum Efficient Scale for LHDs exists at 100,000 population as suggested by Santerre (2009), then that should have become apparent in Bernet & Singh's (2013) study. However, as noted above, Bernet & Singh found a linear relationship between per capita expense by an LHD and population. One of the confounding factors in Bernet & Singh's study was the robust organizational networks between local health departments in Ohio. These formal and informal networks covered a variety of services and program lines and were impossible to separate out in the Bernet & Singh study. The networks likely impacted the cost of delivery of service in the Bernet & Singh study. As Varda et al.. (2008) suggest, "[a collaborative] network does not provide a measure of "outcome" or "impact," it does [however] provide a measure of the process that organizations are engaged in to achieve those outcomes." With that in mind, our refined equation, regardless of outcome, is:

F(Per Capita Cost) = [Population + Performance + Network]

As reflected in Figure 3, the cost to deliver services in jurisdictions is dependent on a series of factors, some of which are in the control of the LHD. The strongest predictors of cost are the demographics of the jurisdiction such as size in addition to legal mandates or communal need. These factors directly impact an LHDs resources and programming, which they have limited control over. An LHD also have some ability to control their performance. When combined together, all of these factors lead an LHD into decisions regarding cross-jurisdictional sharing or even consolidation. In the model, large LHDs (greater than 100,000) are more likely to be resourced sufficiently to meet national standards and perform efficiently with fewer cross-jurisdictional relationships. Small and medium sized health districts with fewer resources, or who fail to meet the Minimum Efficient Scale, are more likely to engage in CJS as a means of ensuring performance standards are met. This leads to increased participation in CJS arrangements.

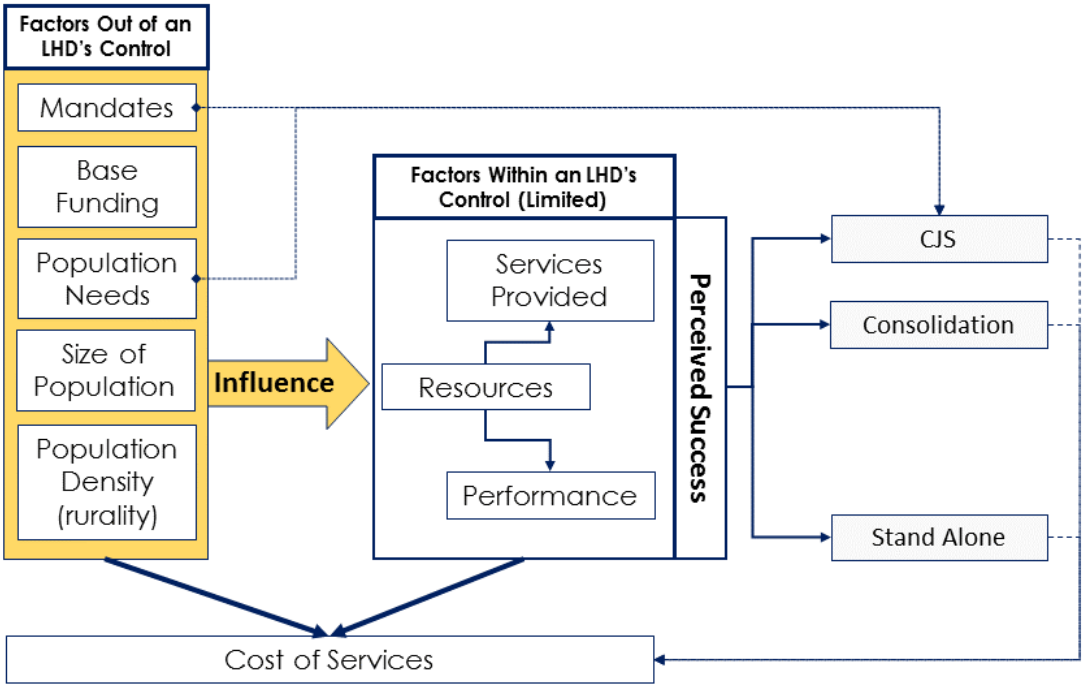


Figure 3. Conceptual Framework of the Relationship between Cost Drivers & CJS

Ic. Initial Theory & Study Questions

In order to meet rising performance standards during an era of decreasing financial subsidy, local health departments have increasingly developed cross-jurisdictional service agreements with adjacent peers. Not only have these organizational networks allowed small and medium sized jurisdictions to contain costs, they have allowed LHDs to meet rising performance demands while containing costs; requirements that larger districts, with their broader infrastructure, can more easily absorb. Social Network Analysis (SNA) allows researchers to formally investigate the impact of these relationships on performance and cost.

Study Questions

How do the key characteristics of an organizational network impact the cost of delivering core services within Ohio's local health departments?

Sub-question 1. What is the relationship between an organizational network's characteristics and the performance of local health department as represented by the NACCHO Profile or comparable performance standards?

Sub-question 2. How do the characteristics of the organizational networks of local health departments differ based on the size of the jurisdiction?

Sub-question 3. What is the prevalence and effect of cross-jurisdictional sharing, or increasing network linkages, on to core or foundational services?

Hypotheses

H0: In Ohio, CJS --as measured by the Strength and/or Breadth of Peer Network-- has no impact on a Local Health Department's expenditures related to meeting Core or Foundational Services.

H1: In Ohio, small and medium LHDs are more likely to have more varied and stronger CJS (direct network connections with their peers).

H2: In Ohio, a robust social (organizational) network is associated with of the percent of Core or Foundational Services provided by small and medium LHDs.

H3: In Ohio, large LHDs receive diminishing benefits from peer networks as compared to small to medium LHDs.

H4: In Ohio, a robust social (organizational) network reduces the cost of small and medium LHDs in meeting Core or Foundational Services.

For the purpose of the study, organizational network is defined as the various links between an LHD and its partnering LHDs (or their representatives) and the cross jurisdictional sharing (CJS) maintained by the agency.

II. Literature Review: Performance, Efficiency, & Organizational Networks

The value of the proposed investigation is derived through what is absent in the existing literature. As will be presented, a growing body of literature supports the impact of population or jurisdiction size on performance and cost of service delivery. There is also gathering evidence of the

value in regionalization and CJS in other disciplines. These various lines of inquiries are building a solid foundation in regards to the optimal size of a jurisdiction, but few account for the use of both formal and informal CJS on the provision of local public health services.

The literature review focused on those elements in the proposed model that appear to have the most influence on cost, i.e. jurisdiction size, performance, and organization. In addition, research on regionalization, cross jurisdictional sharing, and network analysis were also conducted. Many of the articles originated in traditional public health journals such as *Journal of Public Health Management and Practice* but the limited availability of public health research and network analysis or CJS required broader search and use of other disciplinary titles such as the *American Journal of Sociology* and the *Journal of Economic Perspectives*.

IIa. Accreditation and Performance

The focus on performance is an attempt to understand the factors in the public system that are linked to health outcomes and to capitalize on that knowledge to develop a more efficient system. This is ultimately a concentrated effort to strategically resource public health to improve population health outcomes (HHS, 2008), but the effort is hampered by gaps in our knowledge. As Hyde & Shortell (2012) suggest, "There is 'relatively strong evidence' public health expenditures and per capita funding are associated with performance, but this analysis is hampered by lack of data uniformity … [and] there is a "surprising lack of research" regarding "best practices" for public health agencies serving small and rural populations." Most agree though that the most efficient way to embed quality in local public health is through the accreditation process.

Though the actual impact of Voluntary National Accreditation is unknown, performance has been examined in the literature for local health departments. A 2011 study by the Minnesota Public Health Research to Action network provides a comprehensive literature review of LHD performance. In their examination, they identified nine factors in the literature associated with performance: population size, LHD expenditures, Sources of LHD Funding, LHD staffing, Director Qualifications, Organizational Structure, Governance, Partnerships, and Community Characteristics. Even though many studies were identified, their review found limited studies that used performance indicators associated with national accreditation. Rather than discuss each of the studies, only those that seem most closely linked with issues in the *Futures* report are reviewed here.

Lovelace (2001) found links between the management team's structure and operation and performance on core functions. The effect of this seems to be related to a greater emphasis on community assessment and interaction. Similarly, work by Mays (2011) found that governmental structure played a

significant role in the performance of a local health department. While individual benchmarks were associated with different structures, overall he concluded that decentralized or mixed models appear more effective than centralized models. Interestingly, decentralized systems perform better in three EPHS (health status monitoring, educating the public, workforce development) but fare poorer in investigation and research. Given that decentralized models are by nature self-limiting, it is reasonable to assume that higher order or more specialized roles are not a priority compared to other core functions with higher local relevance, such as health status.

A recent literature review by the Minnesota Public Health Institute (2011) found links between LHD performance with what would be traditionally considered outcome measures. Similarly, Kanarek et al. (2006) exploratory analysis found evidence that LHD performance contributed to improved health status indicators. Though this did not hold true for all measures and may have been linked to the local nature of interventions.

Accreditation with its focus on the ten essential services (EPHS) does play into the original goal of the administration and several others on the committee who would like to see a reduction in the number of LHDs. As Hyde et al. (2012) and others have found, population size, location within an urban municipality, poverty rate, annual municipal budget, and presence of a full-time health director are associated with greater capacity to perform the 10 EPHS. Hyde et al. (2012) specifically identify the, "long road ahead that small [LHDs] face as a national accreditation program gains momentum. With the subcommittee's strong recommendation leaning towards a mandated accreditation, it would surely drive many LHDs into mergers or out of the public health business altogether.

Performance has been linked to the presence of a local board of health, whether the board sets policy, whether local public health agency's top executive has a nursing degree, and the population size (Bhandari et. al., 2010). The presence of the local board was the most consistent predictor of performance on the essential services. Unfortunately the relationship was negatively associated with performance. In the study, larger population size is associated with stronger performance in research (EPHS 10); that the background of the top executive makes a difference; and that BOHs are a mixed blessing.

Per the classification scheme crafted by Meit et al.. (2012), Ohio's decentralized public health system fits well with the state's constitutional emphasis on home-rule. This presents several challenges in the delivery of public health services to the entire population. Decentralized states tend to have fewer FTE personnel per 100,000 population and spend less per capita (mean = $145.91 in centralized states compared with $70.22 in decentralized states in FY09) (Meit et al.., 2012). These issues are only compounded when the state's chief executive, the governor, is decrying the burden of local government. The Governor's office has repeatedly challenged the cost and expansiveness of local government in Ohio.

The cabinet's rhetoric often centered on consolidation and regionalization, a particularly unpopular prospect in a home rule state.

Local public health finance is a long debated and sensitive subject for everyone involved. Conventional wisdom is, "Poor health districts remain poor while wealthy districts continue to flourish". This is not unknown in the literature which has found evidence that money begets money (Bernet & Singh, 2007). Local agencies that receive more federal or state dollars tend to be more competitive and able to attract additional dollars.

Mays et al.. (2011) found strong evidence that an association between increased local public health expenditures and decreases in all-cause mortality and select morbidities exists. This is bolstered by the work of Erwin et al.. (2011) who found similar increases in spending linked to decreases in infectious disease morbidity. It is believed by many in the system that current funding is woefully inadequate for the roles LHDs play. This has been quantified in a study of Minnesota's local health districts which found that current funding needed to be increased by 10.7% to adequately fund the local public health system thus bringing the total to $65.24 per capita (Riley et al.., 2011). However, in a study of Florida's public health system, the research team failed to find a direct link between the level of funding of each specific essential services and their respective performance scores (Brooks et al.., 2009). Nor was performance linked to per capita expenditures in a study of Minnesota's public health system (2011).

In a separate study, Hyde et al. (2012) found that public health performance in Massachusetts was greatest in essential service 2, diagnose and investigate health problems, and essential service 6, enforce laws and regulations. In the study, a clear relationship between population size (jurisdiction size), poverty rate, and annual municipal budget were indicated. This was similar to the Mays et al. (2004) study where system and community demographics accounted for up to 28% of the variance in the model and population had its greatest impact on jurisdictions between 20,000 and 100,000 population. The relationship between performance and population was nonlinear and the size of jurisdiction had a marginal effect for jurisdictions greater than 500,000. For some of the essential services, a negative association was identified. What was clear from the study was that spending by the LHD and type of LHD were the best predictors of performance. "Coefficient estimates indicated that an increase in per capita spending by 1 SD was associated with increases in performance ranging from a low of 0.09 SD for evaluating, ES 9, to a high of 0.19 SD for public health research, ES 10. Staffing was only associated with ES 3, educating the public, and negatively associated with linking people to needed services, ES 7. County and combined performed better than all other systems in 4 of the ES including investigating threats, ES 2, educating the public, ES 3, linking people to health services, ES 7, and enforcing laws, ES 6. Multi-county jurisdictions showed lower performance levels for 6 of the ES than county or combined," (Mays et al., 2004).

Local public health does not practice in a vacuum and the extensive use of network partners has influence on performance. Lovelace (2000) examined LPH external collaborations' impact on LPH performance and found that greater collaboration with diverse partners was linked to better performance based on the results of a survey of health directors on the extent and productivity of collaborations on 5 point Likert scale regressed with census and rurality (USDA Urban Influence Code) used as control variables. It is unclear from Lovelace's research whether high performing LHDs are more likely to attract collaborators or if collaborating boosts performance. Regardless, to be productive, collaborators must 'court' one another frequently. Both must work to maintain the relationship after the courtship—typified by open and consistent communication. Further research has found additional evidence that networks of higher density and complexity in all ties and strongest ties networks were positively associated with better performance on 3 of the 10 essential services, ES 4, mobilizing community partnerships, ES 7, linking people to health services, and, ES 9, evaluating health services (Merril et al., 2010). Higher centralization of the strongest ties network was also associated with better performance of these services

From the current literature it is clear that not only is there an apparent relationship between the per capita expenditure of public health and improved performance of local health departments but also that high density networks are specifically tied to improved performance. While outcome research associated with performance is still in its infancy, there is some indication that improved performance likely has an impact on health outcomes as with the Mays et al.. (2011) study.

IIb. Resources, Minimum Efficient Scale & Long Run Cost Average

Performance may be critical to public health professionals, but this is a secondary concern behind efficiency and cost for many elected officials and policy makers. Within the halls of statehouses across the country, efficiency of local government is a driving factor (Beyond Boundaries, 2010). Understanding and identifying a mechanism for funding local public health is made complex by several factors not least of which is an understanding of what services all local health departments should provide.

However, researchers have attempted to explore the economies of local public health through a lens tined by similar work examining health care systems. Within the health care literature, the concept of economy of scale (and diseconomy of scale) is fundamental. In traditional thought, systems find that production costs decrease as efficiency is gained and then eventually begin to increase as a system's size and complexity begin to work against efficiency—a classic U-shaped long range average cost curve. However, health care systems often see an L-shaped, long range average cost curve (LRAC) indicating that the a hospital system gains efficiency and reduces cost to a threshold that then holds to a certain

unidentified future point (Finkler, 1979). This does not support the unhindered growth of health care systems, but suggests that there is no obvious diseconomy of scale.

This is certainly a theme that seems to be reflected in Santerre's (2009) work on public health spending in Massachusetts. Since public health is a collectively provided public good, there exists a non-rivalry in consumption—one person's enjoyment does not detract from another's enjoyment of same good and consequently no impact of demand on per capita cost. Which suggests there are other factors at play in regards to per capita cost. Using NACCHO's survey of 2,864 LHDs in 2005, Santerre (2009) examined the Long-run total costs. He found that the provision of clinical services has a direct effect on average costs. Total costs and population were converted using natural log in order to transform the skew into a normal curve (both were skewed left due to large number of small jurisdictions with small expenditures). The log of the number of services was also used. The result was all variables were ratio or binary in the final model. The conclusion was that a Minimum Efficient Size (MES) occurs around 100K as the per capita cost achieves equilibrium (diminishing return) beyond that point. MES represents the smallest possible size at which an organization can minimize average costs or per capita costs. This resembled the LRAC proposed by Finkler (1979) for hospitals. Bates and Santerre (2008) quantified this relationship as a 1% rise in in population resulting in 1.6% decline in public health spending per capita. Conversely, higher population jurisdictions were linked with higher rates of funding and broader ranges of services (Bernet & Singh, 2007).

When Bernet & Singh (2013) examined Ohio's financial data, the expectation was support for either Santerre's Minimum Efficient Scale or L-shaped cost curve; instead the result was the surprising linear relationship between population and cost. It is this finding that begs the question of what impacts are organizational networks having on public health costs in Ohio. In a national study of private health systems, the proportion of hospital services provided at system level had a negative association with hospital cost and curvilinear with network use (Proenca et al., 2005). One of the findings was that the benefit of a network, as measured by reduced cost, depended on the degree of collaboration; loosely structured networks reduce cost initially but costs rise as collaboration increases and coordination of the system becomes beset by inefficiencies. However, traditional thought still holds that belonging to a strategic organizational network brings with it increased resources (financial & human) while simultaneously decreasing costs (Provan & Milward, 2001).

Regardless of the impact of population on the per capita cost, the majority of public health officials feel that funding is insufficient for demands on the system (AOHC Future, 2012; Riley et al., 2011). In a multi-method analysis of Minnesota's public health funding, Riley et al. (2011) found that per capita funding was $6.32 or 10.7% less than what experts felt necessary to adequately fund the system based on operational estimates. Certainly there is evidence that the level of local government spending

varies with type of county system, but little to show that modernizing or reforming local government results in reduced taxes (Benton, 2002). Levi et al. (2007) summarized the need in three ways: greater investment is necessary in the public health system; the Federal government is the best mechanism to level the financial playing field; and financial systems in public need to be upgraded to allow better clarity and accountability regarding how the funds are used.

Classic economic theory speaks to both economies and diseconomies of scale. It seems legitimate to equate the experience of the heavily researched health care industry's experience in this regard to local public health. Certainly research such as Santerre's (2009) demonstrated the expected LRAC (Finkler, 1979) and found no immediate evidence for a diseconomy of scale but clearly found inefficiency for jurisdictions below 100,000 population. This was not the experience of Bernet and Signh (2013) when examining Ohio, however. They found neither economy nor diseconomy of scale. Neither study examined the impact of CJS on their cost models. However, strategic alliances in the private sector or CJS in public are both done with the intent of driving down cost and garnering resources (Provan and Milward, 2001). CJS needs to become a routine component of local public health cost models.

IIc. Consolidation, Organizational Networks & Cross-Jurisdictional Sharing

Since its inception in 1919, the nation's comprehensive local public health system has been a constantly evolving social experiment. Today's LHDs are positioned differently in their respective communities than they were in 1920, 1950, or even a decade ago. While this evolution will continue, the structure is relatively stable with more than 80% of the population of the United States served by a local or regional health department (Beitsch et al., 2006). Seventy percent of the US population is served by only 17% of LHDs (Mays et al., 2010) which leads us to the conclusion that a majority of the LHDs serving the US are small, less than 100,000 population districts, which provides many opportunities for networks to develop and enhance the ability to provide services.

It should be noted that local public health networks are traditionally a blend of private/ public partnerships, but in regards to the proposed research the focus is almost exclusively on governmental public health networks. Public sector networks are different than private, for profit, and characterized by diversity and politicization (Provan & Milward, 2001). While private sector networks are most often initiated and maintained as a means of acquiring resources and building profits (Provan and Milward, 2001), public sector networks are most effective when they enhance the capacity of organizations to serve clients and/or solve problems (Provan & Milward, 2001). For local public health, the success of a network is measured in its ability to achieve community level goals and determined by its constituents.

Networks that form organically-- that is to say through common need, purpose, or interest-- are stronger and more likely to generate the desired results (Das & Teng, 2000; Chisholm, 1998; Visser, 2004). Voluntary participation in such networks tends to strengthen 'communities of interest'. To be successful, local units must believe that collaboration is positive for their community, that locals retain some measure of autonomy, and it must be locally driven (Visser, 2004). Much like social networks, commonality in culture and demographics, or homophily, (Mcpherson et al., 2001) tend to be the defining nature of organizational networks. Generally, there appears to be an openness to further collaboration in the public system (AOHC Future, 2012; Felton & Golbeck, 2011). Certainly organizational networks have been used as a means to expand services. In a meta-analysis by Hyde & Shortell (2012), one of the most consistent findings across studies is that the greater the population size served by an agency, the more likely that agency will provide the 10 "Essential Public Health Services." Naturally this tends to suggest expanding population base for certain services will result in higher performance as measured by achievement of the 10 essential services. Certainly experience has found that collaboration between districts tends to be in those areas of most associated with population-based public health, i.e. assessment, assurance, and advocacy (Wholey, Gregg, & Moscovice, 2009). However, economic models cannot ignore the influence of social networks on economic activity and productivity caused by such factors as the interpenetration of economic and non-economic action, non-economic activity affects the costs and the available techniques for economic activity—this mixing is known as social embeddedness of the economy (Granovetter, 2005). From Granovetter's perspective, it is less the quality of the social network, or relationships, than its existence that is influencing the outcome.

The nature of the local public health system has a role to play in the development of networks, both internal to the community of local governmental public health and with external partners. Generally, decentralized governance tends towards denser public health systems because of the political nature of local funding while public health systems in large communities to have lower density because the sheer number of potential partners is higher (Wholey, Gregg, & Moscovice, 2009). LPHS density was highest in decentralized micropolitan (urban area with a population of at least 10,000 but less than 50,000) communities and lowest in the decentralized noncore communities. In a 2010 study by Mays et al., seven distinct configuration of local public health delivery systems identified based on work adapted by Bazzoli et al. (1999) on health care attributes: 1) differentiation—different programs and activities delivered through the system; 2) integration—extent to which services are provided through relationships with other organizations; 3) and centralization—concentration of responsibility and effort among organizations within the system. Unlike many studies of LPHS, the results are hampered by only observing LHDs serving jurisdictions of greater than 100,000 population. In this instance of the 2,864 NACCHO identified LHDs in 2005, the study was limited to 497 serving greater than 100K.

The current literature has identified several key concepts that may drive the influence of CJS on the cost model. Successful partnerships or CJS involve trust and shared mission (Chisholm, 1998) as well as growing organically from the organizations involved (Visser, 2004). Measures of involvement such as centrality and density are important but may not provide an indication of the value of the relationship. Trust and reciprocation may be hallmarks of a lasting and positive CJS. The LHD experience with CJS is influenced by the type of system in which it operates (Mays et al., 2010) and its capacity to provide the ten essential services (Hyde and Shortell, 2012). While LHDs are open to expanding the use of CJS in order to retain local autonomy, current studies of CJS fail to examine the impact of CJS on the actual cost of service delivery.

IId. Summary

As presented, clear evidence is gathering supporting the concept of Minimum Efficient Scale in terms of cost (Santerre, 2008) and performance (1, 2).The main factor to date has been the size of the population served. The research has also been rooted in economic concepts applied to health care systems (Finkler, 1979) and is only now beginning to examine local public health in its own unique light (3). Local public health is unique in its operation and financing. Unlike the health care sector, LHDs are not competing with one another. Instead LHDs engage in numerous strategic alliances both within and without their jurisdiction in order to meet the growing demand for local public health services. It is this vast network of partnerships and the influence they have on the performance and cost of services that is the focus of this study.

III. Study Design, Data, and Methods

IIIa. Analytical Approach

Study Design

The study was a mixed methods design containing two distinct yet ultimately complimentary phases. The first component, or phase one, was a qualitative study of the organizational networks of local health departments while the second was an archival analysis of LHD performance, expenses, services, and population. Based on the work done by Bernet & Singh (2013), the second phase incorporated the findings of the first—network analysis-- to examine the impact of the CJS networks on LHD expenditures.

As befits a mixed methods study, the effort drew upon data from a number of sources including archival and original data to create a master data set. With the unit of analysis being the Ohio's local health districts, strict attention to districts created several unique challenges that required the alignment of multiple data sources to build an accurate picture of each local health department's characteristics. It was this that drove the need for a two phased research approach beginning with the network analysis and the subsequent empirical analysis using archival data.

The network analysis was built upon Daniel Varda's PARTNER web-based survey software with additional survey questions developed and vetted with a subcommittee of local health officers. The questions were designed to examine the direction of resources (primarily staff and funding) within the network CJS in more detail. PARTNER's basic functions provided ample detail on the nature of the networks and the relative position of each LHD within the networks. A component of the network analysis included an examination of the cliques, a subset of closely tied LHDs, existing within the network. The network analysis was ultimately used to produce variables to include in the regression model at the heart of the second phase of the study.

The empirical models used historical administrative and operational data, relying primarily on quantitative analysis to estimate the cost of producing public health services. This research built on the RWJ Quick Strike study, Cost of Doing Business, completed by Patrick Bernet & Simone Singh (2013) on behalf of the Association of Ohio Health Commissioners. The RWJ Quick Strike study analyzed public health costs at a macro level. Resource-based models were built using a mix of key informant input, estimates of resource use, and administrative data. Both the Quick Strike and subsequent projects were unable to account for CJS in the economic models. In order to capture the CJS impact, practitioner engagement was needed to collect and understand the empirical data on the costs and network relationships of the 125 Ohio LHDs.

The initial models—known as the Core Plus Scale Model-- was developed by Bernet & Singh (2013) and included data from the following archival sources: Annual Financial Reports of local health departments to the Ohio Department of Health (AFR) which includes expenditures, staffing counts, and organization information; the NACCHO Profile Study; the Ohio's LHD Performance Database (OPPD) which includes performance measures akin to the national accreditation standards; and the US Census. Information collected through PARTNER (organizational network analysis) will be collected and injected into the regression models. The types and sources of data are summarized in TABLE I.

TABLE I. RESEARCH PHASES & DATA SOURCES		
Phase 1: Organizational Network Analysis		**Phase 2: Empirical**
Partnertool.net (Survey of 125 LHDs)	Interview of Directors regarding network analysis (Key Informant Interview)	Ohio Profile and Performance Database (OPPD); Annual Financial Report (AFR); NACCHO LHD Profile; US Census (archival); PARTNER-constructed-variables

Unit of analysis

While the primary unit of analysis was Ohio's 125 local governmental public health organizations, or local health departments, a second unit of analysis was the local public health network including the individual peer networks formed by cross-jurisdictional sharing. Three levels of analysis can typically be identified in this type of system research--community, network, and organization/participant (Provan and Milward, 2001)—this research focused on the network and organizational/ participant levels. Though the cliques examined as part of the study may be partially representative of the community level, since data on non-LHD partners will not be collected in sufficient detail for analysis to warrant time spent examining the community relationships of local health departments. Even with such an understanding, the study recognized that these were a particularly valuable resource for the delivery of both core and expanded services.

While the entire network of LHD relationships were examined and described, particular emphasis was given to the cliques that were unique within the network. These cliques were viewed as they related to the entire network of local public health. The majority of the analysis will be on the organizational level and the influence of the network on the individual participant.

In regards to the local health department, both phase 1 and phase 2 of the research examined LHDs in depth. In Ohio public health is governed and administered by an independently appointed Board of Health in a decentralized local governmental public health system (Meit et al.., 2012). The state Department of Health has little direct control over the administration of a local health department though it does retain influence through the development and adoption administrative code for state mandated programs (such as sewage, food, and swimming pools) and through the control over federal block grants. As of 2012, Ohio's 88 counties are home to a total of 125 local health departments (LHD). Ohio law allows for three different types of health districts—city, general, and combined (ORC 3709.01). General health districts encompass one county and include all townships and villages in the county. A combined district is the union of a general health district and one or more city districts. Typically "general", "county", and "combined" districts are used interchangeably though this can be a misnomer. Unless

otherwise specified in contract, all three reference a 'General Health District' which is the basis for most local governmental public health in Ohio. For all but a few, county districts are co-terminus with county borders. The exception occurs in locations where a city jurisdiction overlaps an adjacent county. Of the 125 LHDs in Ohio, 37 are independently operated city districts. Many more cities are under contract with general health districts for the provision of health services without truly consolidating or merging. Despite numerous consolidations over the past 100 years, Ohio does not currently have any LHDs that combine two or more counties.

Ohio LHDs serve a wide range of population sizes, from 854,975 residents in the Cuyahoga County Board of Health's jurisdiction to less than 12,000 for several small city departments. Overall, 58% of LHDs in Ohio serve small population sizes (<50,000), 39% serve medium or large population sizes (50,000-499,999), and 3% serve very large population sizes (500,000+) (Bernet & Singh, 2013)

The *Futures* (2012) report categorized LHDs by the size of the population served by the district in the following ways:

- Small (2010 population <50,000)
- Medium (50,000-99,999)
- Large (100,000-499,000)
- Very Large (500,000 +)

For the current study, only a distinction between the very large jurisdictions, greater than 190,000 population, was investigated. This was to coincide with the Bernet and Singh (2013) research which also reported statistics for LHDs with less than 195,000 population within its jurisdiction and LHDs with 195,000 or greater within its jurisdictions. The basis for this distinction was the fact that 50% of Ohio's population live within the fourteen LHDs with population jurisdictions with 195,000 or greater. The other half of the population live within the remaining 110 jurisdictions. This is slightly different than dominant thought in the literature. In the literature, the most attention has been paid to the greater than 100,000 population in regards to Minimum Efficient Scale (Santerre, 2009) and 500,000 population as a cap in order to minimize performance loss (Mays et al.., 2006).

IIIb. Network analysis: Data Sources, Collection, and Analysis

The network analysis utilized the PARTNER web-based survey to explore the various dimensions of interrelationship between LHDs. To begin, a draft network survey was constructed in PARTNER using programmatic and services definitions common to the archival data used in Phase 2 of the study (Appendix B). This was to ensure alignment of the data with the definitions of core and clinical services

as used in the Bernet & Singh (2013) study as well as aligning with the available expenditure and performance data.

In order to test the reliability of the network survey, it was given to the nine district directors of the state Association of Ohio Health Commissioners for review and comment. The district directors for the association are elected representatives of the members of the nine health commissioner districts to the AOHC board. They are responsible for keeping members informed, soliciting their input when required, and convening meetings. Involving the district directors served two functions: 1) as Health Commissioners the directors represent the target audience of the survey and so were in the best position to test the validity of the questions and express concerns over collection and, 2) it provided a strong opportunity to educate the directors and seek their support in gaining compliance from the LHOs within their districts in completing the survey. Two items were mentioned by directors in regards to the survey, one was the length of the survey and the second was the 'intimate' nature of the questions. One director in particular questioned whether the survey would garner 'honest' answers. Ultimately, consensus was gained from the directors and the survey was presented to the Board of the state association (AOHC) for approval and dissemination to the membership.

The survey was advertised in both the weekly newsletter and through the directors at regional meetings. The newsletter included a brief article on the purpose of the research for four consecutive weeks. The introduction and repetition was intended to help with increasing the response rate (Borders & Abbott, 1991, p. 193). The district Directors were also asked to follow up through their meetings or by other means during the following the four weeks the research was advertised.

Survey Instrument

While PARTNER has a fully defined set of questions that examine the core attributes of network analysis such as relationship, power, and trust, it does not generate data regarding the specific direction or scale of a relationship, i.e. estimates of contractual values, FTEs, etc. (see Appendix B. PARTNER Survey).

To get the most value out of the regression analysis, certain key variables that expanded on the nature of the relationships within the network were created in the survey. For instance, determining the types of CJS that two or more LHDs engage in and the direction of the relationship is critical in establishing a relationship with cost. Since the second phase of the study involved the cost of providing local public service, understanding who is paying and who is receiving in these relationships becomes critical to interpreting the results of the regression analysis.

The questionnaire included several items known to be shared between jurisdictions through previous research of the association and available for review in the *Futures* report (2012). Items such as epidemiology, WIC, and plumbing are all known to be shared. The top four items in descending order were: (1) Epidemiology services for outbreaks and trending (53%); (2) HIV testing (46%); (3) Lead assessment (44%); and (4) STD testing and treatment (40%). In all, 57% of LHDs self-identified as engaging in current CJS with others local health departments in the *Futures* report (compared with 62% with local, non-LHD partnerships) and 90% identified as being engaged in a contractual agreement to perform a service, though not necessarily on behalf of an LHD (2012).

A subset of items, those that scored greater than 25% shared in the previously mentioned research, were included for possible selection to ensure adequate representation among the respondents. Among those chosen, a balance between clinical and core services were considered so that over representation did not occur. In Ohio, many of the discretionary grants provided from the State Department of Health to LHDs would be construed as clinical and are overrepresented in shared services while not actually being considered a 'shared service' by the study's definition. The current list of explicitly shared services would include:

1. HIV Testing (clinical)
2. STD Testing & Treatment (clinical)
3. Local Disease Investigation (core)
4. Breast and Cervical Cancer Project (clinical)
5. TB Services (clinical)
6. Family Planning (clinical)
7. Help Me Grow (clinical)
8. Child immunizations (clinical)
9. Lead Assessment (clinical)
10. Commercial Plumbing (core)
11. Lead Abatement (core)
12. Solid Waste (core)
13. Smoke-free Ohio Enforcement(core)
14. Epidemiology Services for Outbreaks and Trending (core)
15. Emergency Preparedness (core)
16. Medical Reserve Corps (core)
17. Community Health Assessment Services (core)
18. WIC (clinical)
19. Legal Services (Foundational)

20. Laboratory (Foundational)

While the AOHC survey (2012) captured the CJS in its broadest sense, the categories do not exactly match the categorization used by NACCHO in its own surveys and ultimately NACCHO data was used by Bernet and Singh (2013). TABLE II below shows the final match and selection of the AOHC survey with those used in the 2013 study and ultimately those considered for inclusion in the expanded PARNTER survey. The items in bold were included in the PARTNER survey.

TABLE II. CROSSWALK OF USE OF LHD SERVICES IN NACCHO PROFILE, *FUTURES*, & CURRENT STUDY

Composite Variable	Services Included (NACCHO dataset)	AOHC CJS Survey (*Futures* category)	Final Selection for CJS
Clinical preventive services	Adult immunizations, Childhood immunizations, **HIV screening**, **STD screening**, **Tuberculosis screening**, Cancer screening, Cardiovascular disease screening, Diabetes screening, Blood pressure screening, Family planning, EPSTD services,	**HIV Testing (clinical)** **STD Testing & Treatment (clinical)** Local Disease Investigation (core) Breast and Cervical Cancer Project (clinical) Family Planning (clinical) Help Me Grow (clinical) Child immunizations (clinical) **Lead Assessment (clinical)** WIC (clinical) **TB Services (clinical)**	**STD Testing & Treatment (clinical)** **HIV Testing (clinical)** **TB Services (clinical)**
Medical treatment services	HIV treatment **STD treatment** **Tuberculosis treatment** Prenatal care Obstetrical services Primary care services Home health care School based clinics	**TB Services (clinical)** **STD Testing & Treatment (clinical)**	**TB Services (clinical)** **STD Testing & Treatment (clinical)**

TABLE II. CROSSWALK OF USE OF LHD SERVICES IN NACCHO PROFILE, *FUTURES*, & CURRENT STUDY			
Composite Variable	Services Included (NACCHO dataset)	AOHC CJS Survey (*Futures* category)	Final Selection for CJS
Specialty care services	Dental services Substance abuse treatment		
Population-based activities	Tobacco prevention Injury prevention Occupational safety **Emergency Preparedness** School health Health education **Epidemiological investigation**	**Epidemiology Services for Outbreaks and Trending (core)** **Emergency Preparedness (core)** & Medical Reserve Corps (core) ***Community Health Assessment Services (core)***	**Epidemiology Services for Outbreaks and Trending (core)** **Emergency Preparedness (core)** ***Community Health Assessment Services (core)***
Regulatory-licensing activities	Swimming pool inspection, food inspection, food service licensing, private drinking water inspection	***Commercial Plumbing*** (core) Smoke-free Ohio Enforcement(core)	***Commercial Plumbing***
Environmental health activities	Indoor air quality monitoring animal control vector control ground water protection surface water protection	***Lead Abatement (core)*** Solid Waste (core)	***Lead Abatement (core)***
Other	N/A	Legal Services (Core) Laboratory (Core)	

The final grouping consisted of three clinical services that are shared, three population based services, and two regulatory or environmental health services. The last category being the category with the least likelihood of being shared according to the survey results. Since regulatory authority is a core function of local public health and authority is vested with the local health officer it should not be surprising that this is the category least often shared.

While the types of CJS could be broadly considered to go ad infinitum the CJS questions were restricted, or close-ended, in order to maintain the focus and clarity of the questions being asked (Bordens and Abbott, 1991, pp 184-185). The initial survey was also reviewed and discussed with the AOHC District Directors to insure the reliability and validity of the questions being asked (pp 188). With the multiple opportunities for interaction and discussion on the development of the final tool, the final coding schemes were clearly identifiable before the release of the survey. This was similar to an approach by Birk in an evaluation of network analysis of individual and collective knowledge capacity in the Idaho National Laboratory where extensive effort and key informant review was crucial to the successful development of the network analysis tool (Durland & Fredericks, 2005, pp. 70-71)

The information collected did not include identifiable private information nor should be construed as sensitive. Further, the participants were appointed public officials acting in their official capacity. It is recognized, however, that while the majority of questions are seemingly harmless and publicly available for answer-- such as relationships with other entities-- some of the questions ask about trust and power in the relationships. Since the survey represented minimal risk and asked questions of public officials in their official capacity, an IRB exemption was requested. The University of Illinois at Chicago IRB granted the request for exemption on 02 September 2014, Research Protocol # 2014-0668 (Appendix C).

Sampling

Since the target audience represented a limited population, a nonprobability (convenience) sampling procedure was used, i.e. the entire population of eligible respondents were invited to participate. This was a reasonable expectation given the limited availability of cases and did not increase the likelihood of investigator bias or sampling errors that would otherwise occur in larger populations (Singleton et al., 1993, p. 159). The original goal--given support of the Association and previous efforts (*Futures*, 2012)--was 70% or greater participation from Ohio's local health officers or the LHDs chief executive officer. An email list of all current contacts was downloaded from the Ohio Department of Health's website and cross checked against a list from the Association of Ohio Health Commissioners. If a discrepancy was found between the two lists, the initial contact was sent to the AOHC contact list first.

An initial email request was sent 09 September 2014 giving advance notice that an email request to participate would be sent. The actual invitation from PARTNER with the login information was sent 12 September 2014.

Two additional follow up emails were sent: the first on 30 September 2014 and the last on 13 October 2014. In addition, the District Directors for AOHC also made individual reminders to some of the district members encouraging them to participate in the survey.

Unfortunately, a state public health crisis occurred soon after the survey and likely impacted the final return rate for the survey. Ohio's Ebola state-wide response in September escalated quickly after the arrival to an infected traveler on 15 October 2014. This likely impacted survey return rates.

While all 124 local health commissioners were invited into the survey, only 55 (44%) of LHDs responded whole or in part to the survey. Of those, chi-square tests were performed by region and city-county status to determine whether the resulting sample was, if not expansive, proportional to the total population of local health departments. The chi-square tests found no significant variation from expected in any category of region, $x2(4, N = 124) = 7.293$, $p = .121$, or city-county, $x2(1, N = 124) = 1.984$, $p = .159$.

Though the majority of LHDs did not complete the survey as requested, the 55 who participated in whole or part in the survey created a representative sample along the two dimensions of most importance relative to the study. Other studies have shown that missing data may be possible to overcome through triangulation of linked respondents (Provan et al., 2005).

It should be noted that although the entire population of LHDs did not respond, the nature of the network analysis gave every participating LHD an opportunity to indicate whether a link (arc) existed between their agency (the respondent) and another health district. While this creates limitations in the direction of the relationships from a traditional analysis standpoint, it still creates some image as to how all the health departments in a region may or may not have interactions with a particular department even if that department failed to complete the survey. Consequently, partial data is available for 124 of the 124 possible respondents even with only 55 completing the survey.

Analysis

Using the themes developed through the survey and the review of the initial network maps by the district directors, a cross-case analysis of the individual cliques identified within the network was completed (Miles & Huberman, 1994, pp 172-185). The purpose of the analysis was to develop the analytical frame by which CJS would be examined within the context of the economic regression model (Ragin, 1994).

In addition to the new qualitative questions, PARTNER provided several numeric characteristics of both the entire LHD network and the individual LHD network scores which were later included in the regression model. The individual network scores included: relative connectivity score, key player scores (degree centrality), and a redundancy score (effective size). Per the PARTNER technical manual:

- Relative connectivity: The connectivity score is an indication of how much each member is theoretically benefiting by being a part of the network, relative to benefit received by being connected to other members of the network. The scores are based on a combination of three components: trust, value, and number of connections. A member gets a high connectivity score when they have a lot of connections with valuable partners who trust them. In other words, if a member is engaged in many trusted ties with organizations that the members consider valuable to the collaborative, then they are given a high score. The assumption is that a network member will receive the most amount of benefit from being a member of the network when they are embedded under these conditions. The score is relative to the score of the member with the highest number of trusted connections to valuable partners.
- Key players: Key player scores identify network members that hold central positions within the network. Centrality measures include degree centrality and closeness centrality. Degree centrality is a count of the number of connections a network member has to other members of the network. It is often thought that a member with a high number of connections holds a central position by being highly embedded in the network. Closeness centrality is an indication of the number of edges [steps] between a member and all the other members. A high closeness centrality score (closer to 1) indicates members who have the least number of [connections] between themselves and other members. Members with high closeness centrality are considered central because they can most easily reach other members of the network. Figure 4 provides a simple illustration of centrality measures.
- Non-redundant ties (effective size): This is an indication of the number of edges between a member and all the other members. A high closeness centrality score (closer to 1) indicates members who have the least number of edges between themselves and other members. Members with high closeness centrality are considered central because they can most easily reach other members of the network. This is ideal if, for example, members wanted to quickly spread news within the network. A strategy to do so would include first giving the news to the members with the highest closeness centrality and asking them to tell the network members they are connected to.

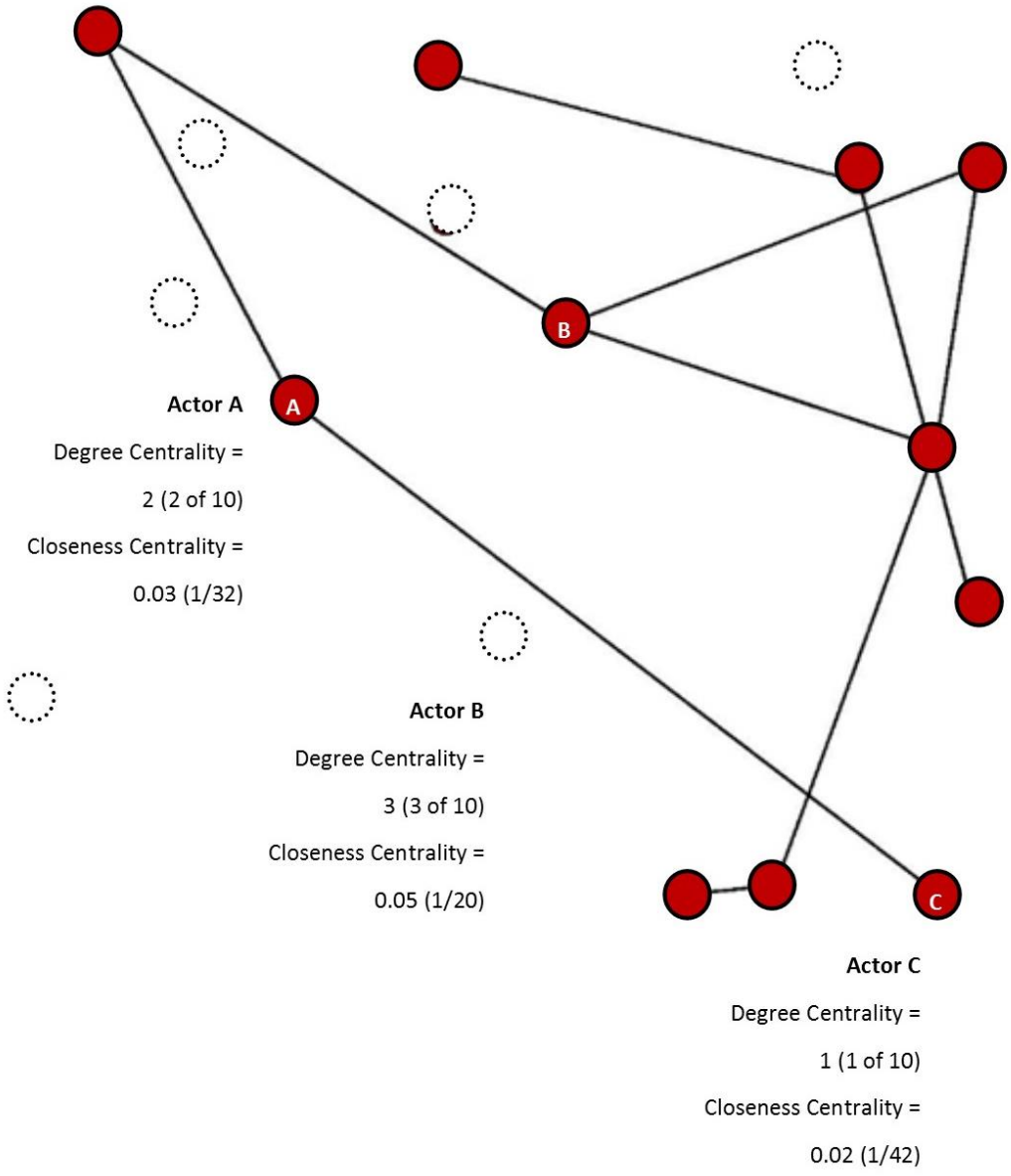


Figure 4. Sample Network Map Illustrating Network Measures

IIIc. Empirical (Economic) Model: Data Sources, Collection, & Analysis

Regression Model

As described earlier, two separate lines of investigation were employed: the first, a network analysis that ultimately informed the second, an economic regression model. Following collection of the organizational network data through the survey process and the evaluation of the both the system and individual LHDs, the resulting data was coded into variables for inclusion into the economic model

It was believed that the addition of the network data would help to tease out the presence and extent of economies—or diseconomies-- of scale as measured by poorer performance within the models. Variations of these models were run to test for possible service mix and staffing mix synergies as with the original Bernet & Singh (2013) study. This item-level analysis was informed by Quick Strike study findings, which examined basket-level pricing and identified staffing mix synergies. Personnel costs were separated based on full-time equivalent employee counts and salaries. Performance and service mix was also evaluated. The core variables for the model are indicated below:

Dependent Variables

- Cost of Core Staffing, Cost of Core Spending, Clinical Staffing, Clinical Spending, 2012

Independent (Predictor) Variables

- Type of Local Health Department
- Log of population, 2010
- Percent of population rural, 2010
- Percent of population nonwhite, 2010
- Percent of population non-English speaking, 2010
- Percent of NACCHO services performed
- Physicians per 100,000 population
- Percent of population of Uninsured, 2010
- Percent of population 65 years and older, 2010
- Percent of staffing dedicated to direct care
- Organizational Network Score Measures, 2014 (new statistics)
- Count of Grants. A count of all grants received by an LHD from the Ohio Department of Health (2014)

The natural log of population was used to control for variations in population density and size. Log transformations in regression models can be justified for any of three primary reasons: "(1) to stabilize the variance of the dependent variable, if the homoscedasticity assumption is violated; (2) to normalize the dependent variable, if the normality assumption is noticeably violated; (3) to linearize the regression model, if the original data suggest a model that is nonlinear in either the regression coefficients or the original variables" (Kleinbaum et al., 2008, p. 303).

The nominal variable "LHDTYPE" was also used. This dichotomous variable was classified as either '0' for a county jurisdiction or '1' for a city jurisdiction es (McCLendon, 1995, pp. 204-211; (Kleinbaum et al., 2008, p. 217-219).

The final variable, COUNTODH, was created after review of the PARTNER data. In PARTNER, LHDs were asked to comment on the type of services shared between LHDS, i.e. TB Control, Plumbing Inspections, etc. In analyzing the data from the network analysis it became apparent that the programs most often shared were those linked to grant funding offered by the state department of health. A request was made to the Ohio Department of Health for a list of all current grant recipients by program. The list was compiled for LHDs (many recipients were not LHDs) by program. All programs were then condensed to a single, variable-- 'Count of all ODH'-- that represented all sponsored grants funded to local health departments. This continuous variable became a substitute for using the nominal variables gathered in the network analysis.

The results of the network analysis and initial review of the networks by the key informants helped inform the creation of the organizational network variables. The variables tested include all those provided by PARTNER directly, as well as a variable created from PARTNER data and one created from data supplied from the Ohio Department of Health:

Additional Independent (Predictor) Variables

- Composite score of Power/Influence, Level of Involvement, and Level of Resource Contribution;
- Level of Involvement. defined as: the organization/person is strongly committed and active in the collaborative and gets things done;
- Level of Resource Contribution. Defined as: the organization/person brings resources to the collaborative like funding, information, or other resources;
- Composite score examining reliability, support of mission, and open discussion;
- Degree centrality. Count of the number of connections a network member has to other members of the network. It is often thought that a member with a high number of connections holds a central position by being highly embedded in the network;
- Relative connectivity. Connectivity score is an indication of how much each member is theoretically benefiting by being a part of the network, relative to benefit received by being connected to other members of the network;
- Closeness centrality. An indication of the number of edges between a member and all the other members;
- Non-redundant ties. A count of the number of non-redundant ties in relation to the other members that each organization is connected too;

- Integrated Arcs. Indicates the number of arcs, connections between LHDs that have been identified as having an 'integrated' relationship in the survey response.

Both composite scores and the individual values of the index scores were tested in the model though only the composite score is indicated above. Particular emphasis was placed on those indicators that by definition would point to CJS such as "resource contribution" or "level of involvement" and so they are specifically mentioned. PARTNER makes it possible to isolate only those relationships that LHDs marked as, "integrated". Since this would best represent shared services and not merely a relationships, Integrated Arcs was created and used in the regression.

The use of the network measures in the regression model allowed for the examination of how CJS was influencing the cost of service delivery. Bernet and Signh (2013) accounted for significant amount of variance in their study (adjusted R-squared of the model was 0.90), what was unknown in their study was whether CJS was confounding the financial data reported by the state department of Health. The AFR report did not delineate when and who is receiving funds to cover additional jurisdictions. And yet the performance data would indicate that all covered jurisdictions are receiving services. The result is that small, possibly inefficient LHDs, have artificially low per capita spending because they are subsidized by surrounding districts who are providing core services on their behalf. The use of SNA was meant to tease out this phenomenon if it existed. The thought being that if it did exists, then it is possible the linear relationship identified by Bernet and Singh (2013) would change to demonstrate efficiencies of scale within larger jurisdictions. It may also provide information as to what are key characteristics of networks that are influencing performance and cost.

There was a final concern of the proposed model surrounding Bernet's and Singh's original findings. In their model, the regression produced an adjusted R-squared of the B-model of 0.90, explaining about 90% of all the variation in core staffing (0.92 for core funding levels) with Cities showing a net negative impact on both. This value decreases significantly for clinical models with an adjusted R-squared of the B-model of 0.58 for core staffing (0.57 for core funding levels).

Given the incredibly high percentage of variance explained, it seemed unlikely that the R value would increase with the addition of the new measures. However, one of the key variables from the original model was "City/County". This may be explained by the nature of shared services in Ohio. The proposed model predicted that the nominal variable "City/County" is actually a proxy for other measures of CJS. This is reasoned by the nature of programming construction in Ohio where, for instance, federal disaster preparedness funding is distributed on a regional level with county level jurisdictions receiving the funds inclusive of city jurisdictions. This is also often the case with other program grants such as WIC, Sexual Health, and Health Promotion.

Data Collection Method

The Annual Financial Report is completed annually by all Ohio LHDs and was the source for most of the financial information used in the Bernet & Singh (2013) model. Their dataset al.so included information from NACCHO profiles which contain detailed information on LHD characteristics, census information on area demographics, community health status data on outcomes, an area resource file, along with other reference data. Prior research demonstrates such factors moderate the costs of public health. All measures were already linked to an LHD shape files as part of the RWJ Quick Strike project, so reference could be precisely tied to LHDs. Empirical data was analyzed for several time periods, so reference files will be similarly aligned. However, the number of LHDs completing the survey varies bi-annually. For example, per Bernet & Singh's (2013) report of the 125 Ohio LHDs, only 103 completed the survey in 2010 and 98 in 2008. For missing values, Bernet & Singh used the most recent previously completed survey. If values had not been included with the past two surveys (four years) then the LHD was excluded from their study.

To benchmark performance, the dataset included self-reported capacity data from the Ohio Public Health Performance Database. The OPPD reports on a LHDs current capacity to meet Ohio public health performance standards which mimic the twelve accreditation standards of the Public Health Advisory Board (PHAB). Finally, as with Bernet & Singh's (2013) study, demographic data was compiled for all included health districts using NACCHO's LHD-to-FIPS code references.

A significant barrier to Bernet & Singh's (2013) study was the inability to define the complex network of relationships that exist between public health jurisdictions. Ohio's LHDs regional and shared service programs confound the expenditure data. These relationships impact both the delivery of service and the cost of delivery. PARTNER data was coded into specific schemes for use in the regression model. This included dummy variables coded for various participation in cliques as well as ordinal data from the PARTNER survey and scale of CJS from expanded question set. The organizational network models rely primarily on key informant input, but also drew on administrative data, where available, to audit the completeness of estimates.

Additional Analysis

In addition to executing multiple variations on the regression model, basic descriptive statistics were completed to examine the distribution of variables, as well as correlations related to the ONS statistics and measures of population distribution.

IIId. Validity & Reliability

The findings from this study were limited in their generalizability since the LHDs studied were only in Ohio; however it was hoped that the study will inform the broader discussion on CJS and local health department performance and funding. The analysis included expert opinion and administrative data to help reduce the threat of desirability bias in the data collected from both the self-reporting of participation in CJS within the PARTNER, NACCHO Profile, and the Ohio Profile and Performance Database.

Though the use of multiple sources of data assisted with construct validity, additional efforts were taken to address the case study's empirical quality. Two of Yin's (2009) suggested tactics were employed albeit in a rudimentary fashion. The first was to have key informants (AOHC district directors) review a draft of the network analysis study. The second was the establishment of operational definitions relevant to the case and research questions based on currently accepted concepts in published literature on network analysis.

Once the network analysis was completed the results were shared with the district directors for review and comment. Similar to Mays and Hogg (2012) a combination of survey results and key informant interviews was used to develop the final network model. The intent was to create a practical understanding of how the organizational data was reflected in practice. The directors affirmed that the network analysis was an accurate portrayal of both the association as a whole and their individual districts.

The case studies were then used to guide the implementation of the second series of analysis, regression of the organizational network data on the Bernet & Singh model.

Similarly, questions exist about the validity of the NACCHO and AFR data. Both data sets are self-reported and not independently verified. Moreover, until recently the state did not use a standard set of definitions for completing the AFR. This issue was corrected beginning with the 2011 dataset. Consequently, economic data drawn from the AFR will be limited to those years with a user manual.

The NACCHO data suffers from a similar lack of uniformity caused by poor definitions and descriptions of terms, missing values, and potential sampling bias caused by the volunteer nature of the survey (the AFR is mandatory for Ohio LHDs).

IIIe. Institutional Review Board

The information collected did not include identifiable private information nor be construed as sensitive. Further, the participants were appointed public officials acting in their official capacity. It is recognized, however, that while the majority of questions were seemingly harmless and publicly available for answer-- such as relationships with other entities-- some of the questions asked about trust and power

in the relationships. However, since the questions represented minimal risk and were asked of public officials in their official capacity, a request for exemption was submitted to the University of Illinois at Chicago, Institutional Review Board. All forms and application documents were compiled per UIC guidelines.

The University of Illinois at Chicago, Institutional Review Board granted the request for exemption on 02 September 2014, Research Protocol # 2014-0668 (see Appendix C).

IV. Results

IVa. Network Analysis

Network Maps

The PARTNER software has multiple dimensions available for investigating the network. While all of these were reviewed, several were dismissed as being of limited value either because responses were very uniform (possible respondent bias) or because the low number of response diminished the perceived generalizability of the responses.

The limited sample made it difficult to analyze the direction of the relationships since information may have only been available for one member of any given dyad. Consequently, much of this information was excluded from analysis.

Furthermore, while PARTNER allows network maps to be drawn based on frequency of interaction from daily to less than annually, most of the maps used in the analysis focused on daily or weekly integrated activities. Since the focus of the study was on shared services, it was believed that a routine level of interaction that was perceived by respondents as *integrated* in nature would approximate shared services.

The nature of the relationship between members of the network is summarized in three ways:

- Cooperative Activities: involves exchanging information, attending meetings together, and offering resources to partners (Example: Informs other programs of RFP release) ;
- Coordinated Activities: Include cooperative activities in addition to intentional efforts to enhance each other's capacity for the mutual benefit of programs. (Example: Separate grant programs utilizing shared administrative processes, policy templates, or forms to deliverables.);
- Integrated Activities: In addition to cooperative and coordinated activities, this is the act of using commonalities to create a unified center of knowledge and programming that supports work in related content areas. (Example: Developing and utilizing shared priorities for funding effective prevention strategies. Funding pools may be combined.)

For reference, Figure 5 illustrates all LHDs in the network having at least some interaction, even less than annually, up to and including daily contact. In all the network maps, the district or region to which the LHD belongs was indicated by color. Only a single LHD was not connected to the network in such a broad representation. This is not surprising given statutory requirements for participation in two annual conferences endorsed by the state department of health, but managed by the state association.

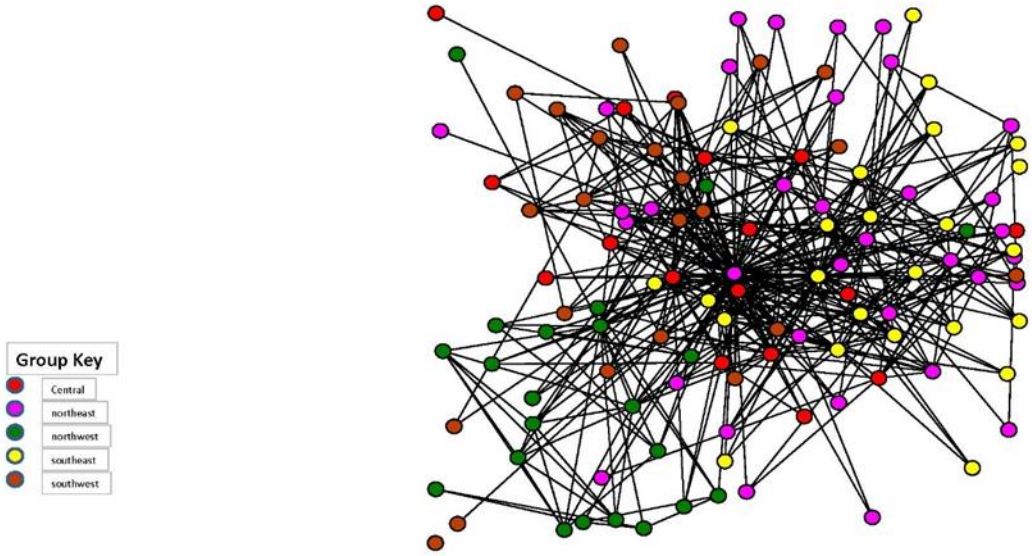


Figure 5. Representation of Interactions between LHDs Occurring less than Once per Year or More.

As can be seen in Figure 5, the network is balanced between many poorly connected actors (having one or two connections) on the periphery of the map and many strongly connected actors (two or more connections) located in the central part of the graph. There was also a single LHD who was not connected to any other jurisdiction.

Since most of the relationships centered on the connection between the LHD and the association, cooperative activities was the default and provided little for analysis. Even when network maps were generated at the district level of the association, all LHDs indicated at least one cooperative relationship within the district membership. When analyzed en masse, it does point to an association of LHDs that encompasses every LHD in the state that have some connectivity. However, the connection between many of the members is weak as represented by both the density and degree centralization (TABLE III).

TABLE III. NETWORK SCORES		
Density	5.80%	Density: Percentage of ties present in the network in relation to the total number of possible ties in the entire network.
Degree Centralization	62.20%	Degree Centralization: The lower the centralization score, the more similar the members are in terms of their number of connections to others (e.g. more decentralized). The higher score reflected here indicates that there are likely one or more 'central' actors who are well connected.
Trust	78.30%	Trust: The percentage of how much members trust one another. A 100% occurs when all members trust others at the highest level.

The LHD network demonstrated a high degree of centralization (62.2%) indicating a network with several key, interconnected members and the majority of members having fewer relationships within the network. This was also apparent in the range and standard deviation of the centrality measures. A histogram of the Degree Centrality for individual LHDs is included in Figure6. As represented, 26 LHDs had a degree centrality >=10. These represent central actors within the network. Of the 124 LHDs indicated in the network, five (5) had degree centrality scores of zero (0). Four were small, less than 25,000 population, city health districts and one was a county health district. It was possible that they did have connections with LHDs who did not complete the survey. Even so, it was likely indicative of very little network activity on the part of the five districts.

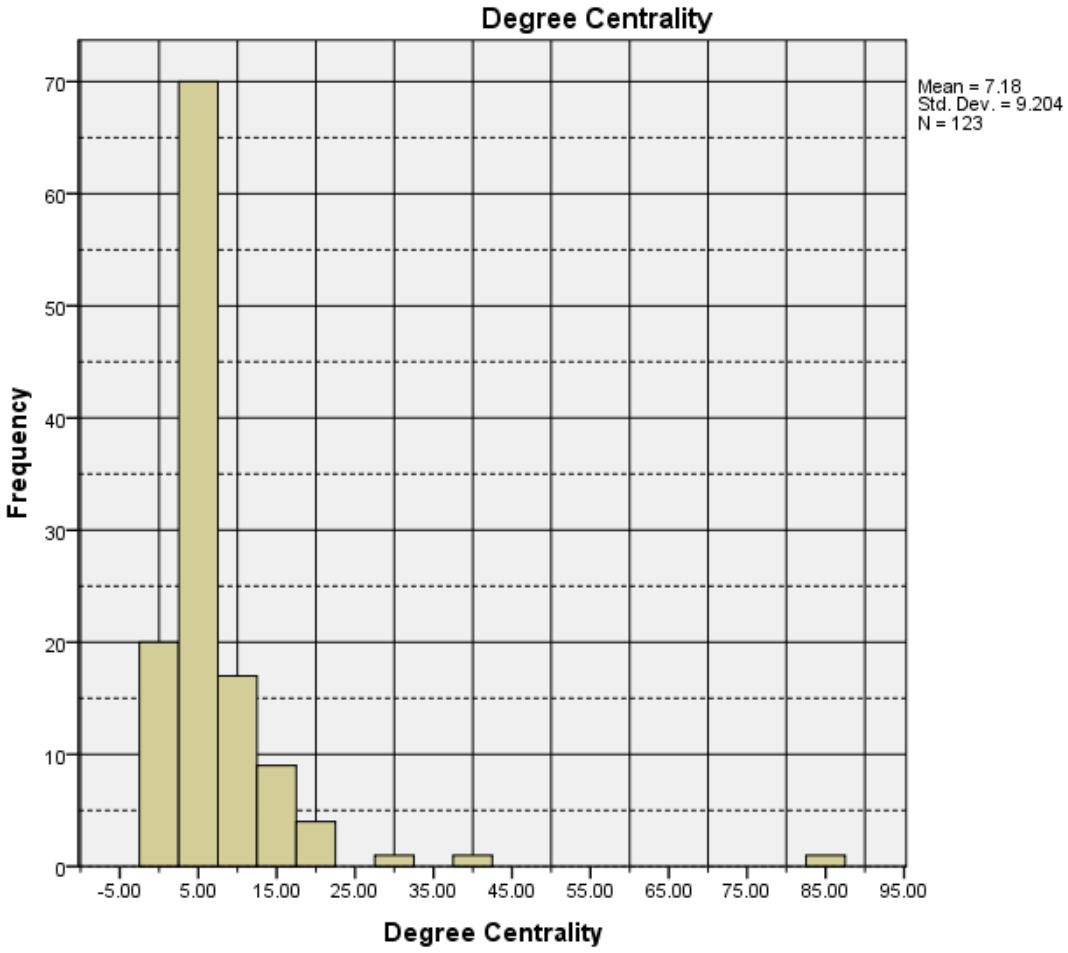


Figure 6. Histogram of Degree Centrality of LHD Network

In exploring the nature of the relationships between the various LHDs, it became clear from the respondents that there was a group of LHDs that had significant and routine interactions, often indicating that they were engaged in financial or staffing relationships. Figure 7 represents interactions that occured at least weekly within the entire network while Figure 8 shows daily interactions. In Figure 3, the color of the node indicated the region/ district that the LHD belonged to in the state association of local health officers (AOHC) while the diagonal line denotes those LHDs (node) contributing direct funding to the network through a contract or similar mechanism. Figure 8 provides the strongest evidence of the breadth of integrated relationships in the entire network with many LHDs shown to be integrated with daily interaction

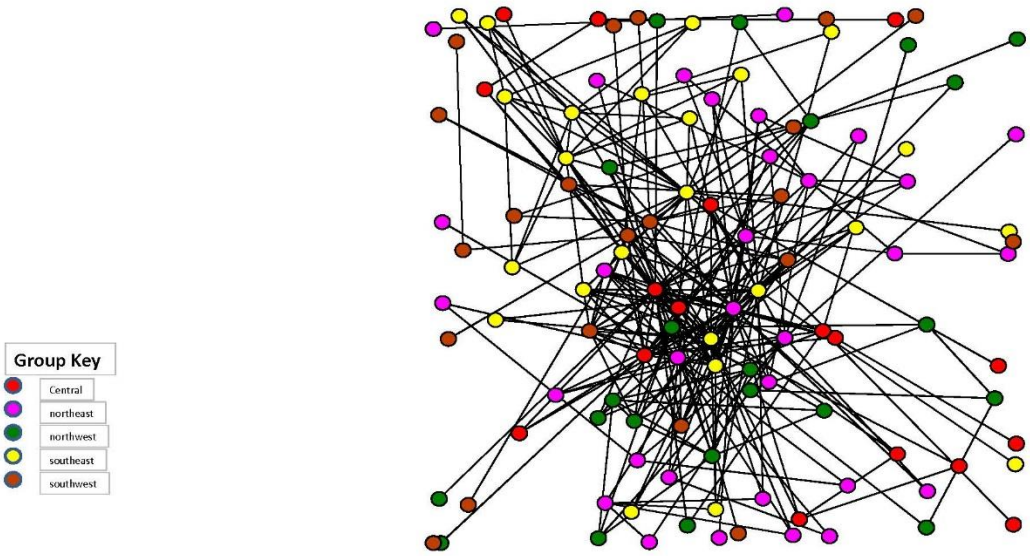


Figure 7. Network Map Displaying Weekly or More Interactions within the LHD Network

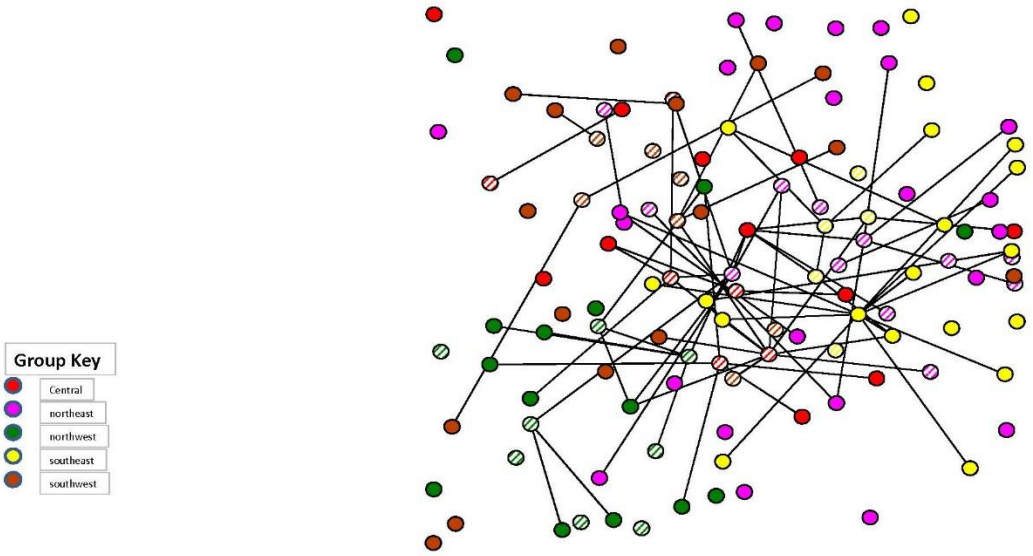


Figure 8. Network Map Displaying Daily Interactions among LHDs with Funding LHDs Identified

In comparing Figure 7 with Figure 8, the integrated nodes of the network become clearer. It is interesting to note that the integrated nodes are not highly centralized but more uniform in their interactions and level of centralization at this level. As noted before, 26 LHDs have a degree centrality of 110 or higher, 63 have a degree centrality between 1 and 5. This is easy to visualize in the map represented in Figure 8.

If the integrated network map is recreated with the size the node denoting the perceived level of resource contribution, a slightly different picture of the overall network emerges. In Figure 9, many of the distal LHDs were indicated by their peers as contributing resources to the relationship even though they were not key actors in the network. In Figure 9, the same entities that had already been identified as central to the network and who contributed direct financial resources to the network were not seen to contribute more than the resources of other members. In examining individual network scores (Table IV) the highly centralized members did not hold any specific position of trust or influence over other members. The number of connections did not readily translate into a perception of higher trust or overall

value. To illustrate this effect, the top nine Degree Centrality scores are compared against their ranking on the two other composite measures, Overall Value and Total Trust, in TABLE IV.

TABLE IV. COMPARISON OF LHD RANKING ACROSS THREE RELATIONAL MEASURES

Agency	Degree Centrality	Non-Redundant Ties	Value Rank	Value Score	Trust Rank	Trust Score
LHD A	83.00	78.08	18.00	3.33	47.00	3.56
LHD B	40.00	34.54	7.00	3.50	13.00	3.86
LHD C	32.00	27.55	8.00	3.48	12.00	3.88
LHD D	22.00	18.78	40.00	3.00	37.00	3.67
LHD E	21.00	16.78	44.00	2.93	4.00	4.00
LHD F	21.00	15.38	29.00	3.15	48.00	3.53
LHD G	20.00	17.24	64.00	2.67	29.00	3.67
LHD H	17.00	11.45	34.00	3.10	15.00	3.79
LHD I	16.00	9.81	42.00	2.96	24.00	3.71

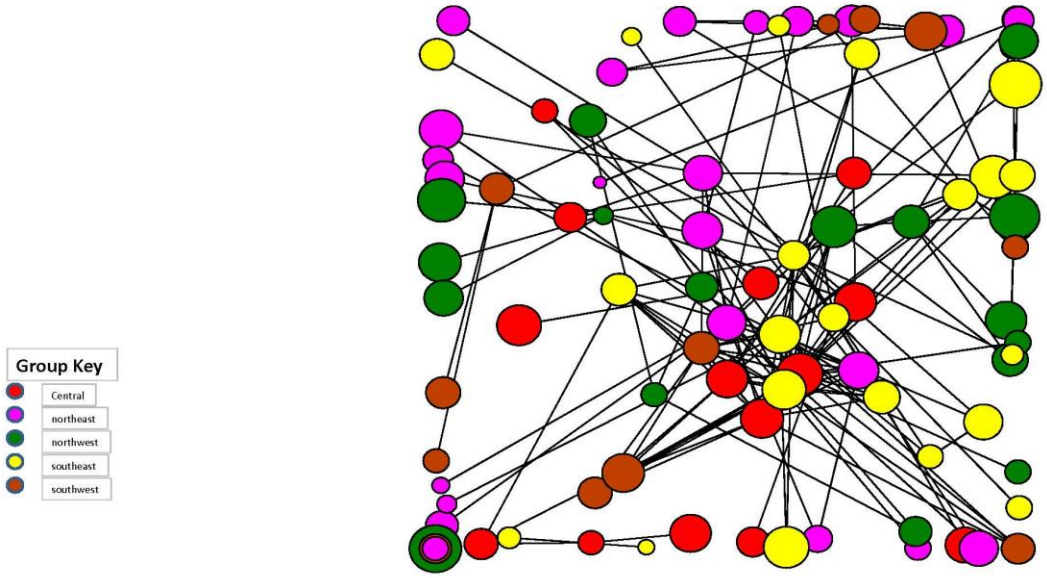


Figure 9. Network Map with the Size of Node Indicating Perceived Value of Resources Contributed

The Value scores, those scores detailing the resources and influence of the members of the network, were modest with most scores falling slightly above the expected average (TABLE V). This is contrasted with the Trust scores which show a decidedly skewed trend towards high levels of trust among members.

The resulting picture is a network with several key actors, with average interactions and subsequent sense of influences, but high levels of trust between the members.

TABLE V. DESCRIPTIVE STATISTICS FOR INDIVIDUAL NETWORK SCORES					
		AVG	**MIN**	**MAX**	**SD**
CENTRALITY/CONNECTIVITY/ REDUNDANCY	**Degree Centrality (max 124):** *# of connections to other members of the network*	7.14	0.00	83.00	9.15
	Non-Redundant Ties: *shows the number of non-redundant ties in relation to the other members that each organization is connected too.*	5.14	0.00	78.08	8.33
	Closeness Centrality: *Measures how far each member is from other members of the network in terms of # of links between each member. A high score (close to 1) indicates members who have the shortest 'distance' between all other members.*	0.44	0.31	0.77	0.06
	Relative Connectivity: *Based on measures of value, trust, and # of connections to others, the connectivity score indicates the level of benefit an organization receives as a network member, in relation to the member with the highest level of benefit (100%).*	0.12	0.00	1.00	0.12
Value(1-4)	**Overall Value** (1-4): *an average of the ranking given by all other members for that organization along three dimensions: influence, involvement and contribution. Scale of 1-4.*	2.67	1.00	4.00	0.12
	Power/Influence (1-4)	2.75	1.00	4.00	0.59
	Level of Involvement (1-4)	2.77	1.00	4.00	0.66
	Resource Contribution (1-4)	2.5	1.00	4.00	0.71
TRUST (1-4)	**Total Trust** (1-4): *an average of the ranking given by all other members for that organization along three dimensions: reliability, support of mission, and open to discussion. Scale of 1-4.*	3.35	1.92	4.00	0.43
	Reliability (1-4)	3.24	1.50	4.00	0.58
	In Support of Mission (1-4)	3.40	2.00	4.00	0.41
	Open to Discussion (1-4)	3.40	1.75	4.00	0.53
N = 124					

The low Relative Connectivity score also points to a network that was loosely connected with a relatively few members deriving significant benefit through its membership. It was then worth examining the individual association districts to see the variations across those cliques to see if variation exists.

District (clique) maps

Figures five through nine represent the five districts of the association. All LHDs were pre-assigned their district though in rare circumstances a district could petition to move to another district. Central district was the newest and was approximately a decade old; the other districts had been in existence and working collaboratively for more than ten years. The districts doo not restrict partnerships, relationships, or programs—they merely facilitated relationships between sets of LHDs relative to the work of the state association. However, this structure tended to influence partnering decisions because of familiarity and history of interaction.

The overall characterization of the five districts maps centers around the breadth of integration or degree centrality (how many LHDs in a district are connected to another?) and the centralization (were the LHDs connected equally?). In each map, a line indicates an integrated relationship between two LHDs that involved at least weekly interaction.

The five districts maps represented in Figures five through nine are all based on an integrated level of activity, approximating a large degree of shared services or decision making. In this context, the least centralized and least integrated district was southwest (Figure 8a) with only three integrated partnerships and many unaffiliated LHDs. Central (Figure 8b) is similarly situated though the partnerships within the district tend to have more connections.

Both northwest (Figure 8c) and northeast (Figure 8d) had broader integration of LHDs. Northeast in particular was more centralized around a couple of LHDs. Both districts still had some unaffiliated LHDs.

Southeast (Figure 8e) stands out for two reasons among the districts: firstly because all but one of the LHDs in southeast were connected to another LHD and secondly, while there were a couple of strong actors in the network, many of the LHDs maintained connections with more than one other LHD. This

was strikingly different that the other four districts. It should also be noted that Southeast District did not include a large district (greater than 150,000 population).

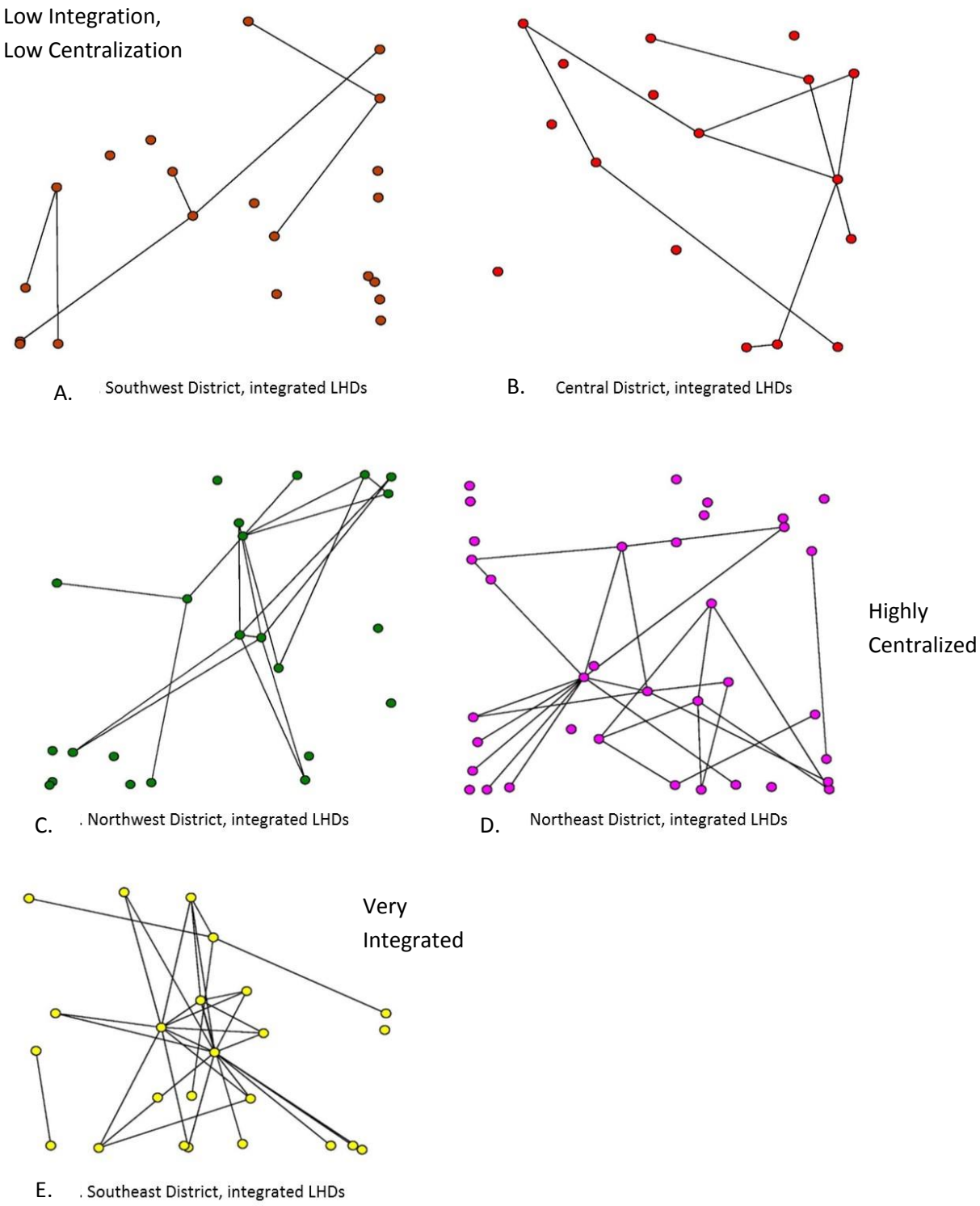


Figure 10. Regional Network Maps of Ohio's LHDs

Qualitative Measures

As discussed in the previous section, the network analysis was hampered by incomplete data, that is to say, the lack of respondents and/or partially completed surveys resulted in poor qualitative data. While the connectivity of LHDs was well represented through the data collection process, getting a complete sense of the qualitative measures was more difficult to ascertain. As a result, much of the information collected by PARTNER paints an incomplete picture of the Ohio LHD network. This was particularly true of questions that spoke to an individual LHD's participation or experience within the network.

TABLE VI. Services Provided or Received between LHDs, 2014

Please indicate what programs your LHD [BLANK] as a member of this local health department collaborative (choose as many as apply).	**Received**		**Provide**	
	Count	% (%*)	Count	% (%*)
STD Testing & Treatment	10	21.7 (7)	11	26.2(7)
TB Services	5	10.9 (3)	7	16.7(4)
Epidemiology Services for Outbreaks and Trending	28	60.9 (19)	21	50(13)
Emergency Preparedness	30	65.2 (20)	32	76.2(20)
Community Health Assessment Services	12	26.1 (8)	10	23.8(6)
Commercial / Residential Plumbing	6	13.0 (4)	8	19.1(6)
Lead Abatement	2	4.4 (1)	7	16.7(4)
Other Environmental Programs	13	28.3 (9)	13	31.0(8)
Other clinical/ public health nursing programs	18	39.1 (12)	19	45.2(12)
Other Health Education/ Health Promotion Programs	14	30.4(9)	19	45.2(12)
Other Public Health Programs not otherwise categorized	12	26.1(8)	13	31.0(8)

**Percentage of responding LHDs (Percentage of all responses)*

TABLE VI provides the responses to what services were, at the time of the survey, being shared between Ohio's LHDs in 2014. The answers are presented in the order asked in the survey. From the survey, Emergency preparedness was the most commonly shared program followed by Epidemiology. Both were grant funded programs with an emphasis on CJS. Emergency preparedness was highlighted as one of the key outcomes as would be expected among Ohio's LHDs given that most of the collaboration around the state was centered on the emergency preparedness and was explicitly funded in a manner that

requires collaborative network activities. This was a theme that would carry through each of the four qualitative questions.

Four questions spoke to the qualitative assessment of the individual respondent, on behalf of the LHD, sense of value that the network relations brought to the agency (TABLES VIIa-VIId).

In examining the perceived outcomes of the network collaboration, the responses were evenly distributed across several of the answers. Of the qualitative questions, this question garnered the most complete responses.

TABLE VIIa. OUTCOMES OF COLLABORATIVE		
Outcomes of this local health department collaborative's work include (or could potentially include): (choose all that apply).		
Answers	***No of responses***	***Percentage***
Health education services, health literacy, educational resources	32	8.70%
Improved/expanded clinical services to the community	34	9.20%
Reduction of Health Disparities	27	7.30%
Improved Resource/ Knowledge Sharing	42	11.40%
Increased Emergency Preparedness	44	12.00%
New Sources of Data	27	7.30%
Community Support	26	7.10%
Public Awareness	33	9.00%
Policy, law and/or regulation	20	5.40%
Improved Health Outcomes	40	10.90%
Improved Communication	43	11.70%

The link between ‘Improved Communication’ and ‘Improved Resource/ Knowledge Sharing’ may also have significant overlap with the ‘Increased Emergency Preparedness’ but it was not immediately clear from the responses.

Lastly, the respondents did feel that the collaboration either had resulted or would result in ‘Improved Health Outcomes’.

TABLE VIIb. OUTCOMES OF COLLABORATIVE		
Which is this local health department collaborative 's most important outcome (or potential outcome)?		
Answers	***No of responses***	***Percentage***
Health education services, health literacy, educational resources	2	3.80%
Improved/expanded clinical services to the community	7	13.50%
Reduction of Health Disparities	3	5.80%
Improved Resource/ Knowledge Sharing	10	19.20%
Increased Emergency Preparedness	9	17.30%
New Sources of Data	0	0.00%
Community Support	1	1.90%
Public Awareness	2	3.80%
Policy, law and/or regulation	1	1.90%
Improved Health Outcomes	15	28.80%
Improved Communication	2	3.80%

In TABLE VIIb, it appeared that LHD respondents viewed the collaborative from the core mission of, 'improving health outcomes' followed closely by improved resource sharing, as would be seen in cooperative networks. The high percentage of respondents who indicated, 'Increased Emergency Response' was also not unexpected given that beginning in 2003 the majority of LHDs were forcibly partnered through leveraged public health infrastructure dollars tied to emergency preparedness--relationships and partnerships that continue today Generally, respondents felt that collaborative efforts were successful with 94% reporting somewhat to very successful. This should not be surprising given that jurisdictions have invested significant resources in their partnerships and would be unlikely to view such expenditures harshly. However, it was worth nothing that the scores are evenly distributed across all three categories of successful. So even if there was a respondent bias in answers, more than 2/3 still chose to mark the collaborations as successful or very successful. This was likely indicative in the value that participants see in their network collaborations.

TABLE VIIc. OUTCOMES OF COLLABORATIVE		
How successful has this local health department collaborative been at reaching its goals?		
Answers	***No of responses***	***Percentage***
Not Successful	2	3.90%
Somewhat Successful	14	27.50%
Successful	16	31.40%
Very Successful	18	35.30%
Completely Successful	1	2.00%

In examining the factors that contribute to the success of the collaboration, answers were uniformly distributed across all possible responses with two standouts: Exchanging info. Knowledge' and 'Sharing resources' which had slightly higher response rates (TABLE VIId).

TABLE VIId. OUTCOMES OF COLLABORATIVE		
What aspects of collaboration contribute to this success? (Choose all that apply)		
Answers	***No of responses***	***Percentage***
Bringing together diverse stakeholders	28	11.50%
Meeting regularly	29	11.90%
Exchanging info/knowledge	45	18.40%
Sharing resources	41	16.80%
Informal relationships created	34	13.90%
Collective decision-making	34	13.90%
Having a shared mission, goals	33	13.50%

This seems to fit with the most commonly observed aspect of the LHD network, that most of the network relationships were cooperative in nature rather than coordinated or integrated networks. LHDs also valued 'Exchanging Info/ Knowledge' above other categories, which would fit with the cooperative exchange perspective of the relationships.

IVb. Results of the Empirical Analysis

Data Set

The data set for the original model was used with permission from Ohio's practice based research network, or RAPHI. The descriptive statistics reported by Bernet and Singh (2013) were compared against a new run of descriptive statistics to ensure the data was compatible. In the course of reviewing the data, one variable, cities, was found to have nine excluded responses. An additional corrected variable for cities was created to adjust for the nine missing values. The impact of the change is reported in Table 5. Otherwise, the dataset matched the original set used by Bernet and Singh (2013).

Several additional variables were created for inclusion in the model and were drawn from the PARTNER survey, which produced a variety of network analysis metrics or allowed for additional metrics to be created, and the second was a report provided by the Ohio Department of Health detailing which LHDs received grants from the ODH. The grant information did not provide details on regional partnerships or the amount of the grant award, only whether an LHD received a grant for a particular program such as Breast and Cervical Cancer Prevention (BCCP) or Public Health Emergency Preparedness (PHEP). Two variables were created for the regressions from this information. A dummy coded variable indicating if an LHD was a recipient of an ODH grant and a second continuous variable, Count of Grants, which was a total count of all grants received by the LHD from ODH.

The grant award count from ODH has varying degrees of importance depending on the complexity and breadth of funding an LHD enjoys. For smaller LHDs, grants from ODH may represent a large source of income relative to overall revenue. For example, in Ohio the federal pass through grant known as PHEP is structured with a base funding amount that is then supplemented with a per capita amount. This results in the grant representing a disproportionate percentage of an LHDs total budget for smaller and medium sized health districts. In addition, the PHEP grant award is generally given to the county health district who then may contract with city districts within the county or multiple districts in the case of the southeastern districts of Ohio, who have chosen to share funds and hire regional staff to support their operations. The result is a skewed budget for districts who take the administrative lead in such arrangements and the possibility of underreporting of actual cost for the recipient districts even though they still derive benefit and can rightfully claim that the district meets all applicable standards. For this reason, the inclusion of a variable to account for some amount of grant activity within each district is important.

For the network scores, a number of variables were created from the Partner data and tested in the regression. Twelve variables were examined in three categories: Centrality, Value, and Trust. As can be expected, several of these variables are highly correlated with one another. Tests for multicollinearity

typically required the exclusion of all but one of the centrality measures in any given regression though variables that looked at the network's perceived quality may have been included. For centrality, both degree centrality and Closeness Centrality were tested in the regressions, though Closeness Centrality was the stronger predictor. After examining network maps for the LHDs, it became apparent that multiple cliques corresponding with districts were embedded with the complete network and within each clique were one or more highly connected LHDs. Using a measure of network embeddedness was considered a strong predictor of cost of core services given that the LHDs involvement with other districts and its potential influence in the network has a cost on operations. The effect is likely more pronounced than the degree centrality measure which only examines direct connection between districts, though that may be a better indicator of shared services.

Descriptive Statistics

The available N of reported variables ranged from a low of 90 of 124 (Clinical Expenditures) to a high of 124 of 124 possible. Analysis involving clinical expenditures had fewer cases because not all LHDs conduct what they consider 'clinical activities' and so do not report expenditures in those areas. This accounts for the lower, valid case counts.

As with Bernet and Singh (2013), statistics for LHDs with less than 195,000 population within its jurisdiction and LHDs with 195,000 or greater within its jurisdictions are also reported. The rational for the original separation was the reality that 50% of Ohio's population live within the fourteen LHDs with population jurisdictions with 195,000 or greater. The other half of the population live within the remaining 110 jurisdictions. Descriptive statistics for these are included in TABLE VIII as well.

TABLE VIIIa. DESCRIPTIVE STATISTICS

			All Cases			
			N	Minimum	Maximum	Mean	Std. Deviation
Original Core-Plus Scale Model	Jurisdictional Characteristics	County LHD	115				
		City LHD	115				
		Population Total (Actual)	124	6,459	853,720	92,948	138,770
		Population; Total (Log)	124	8.77	13.66	10.83	1.02
		% population rural	124	0.00	1.00	0.37	0.31
		% Population Non-white	124	0.01	0.59	0.10	0.11
		Households. % non-English speaking	124	0.00	0.09	0.01	0.02
		% population age 65 +	124	0.07	0.22	0.15	0.02
		Per capita income	124	14,996	49,293	23,077	5,424
		% Population Uninsured	124	0.08	0.23	0.11	0.02
		Mds per 100K pop (phys rate)	124	0.00	167.10	61.45	35.08
	Agency Characteristics						
		NACCHO breadth of coverage	113	2.00	73.00	39.17	12.48
		Naccho % of Services	122	0.00	0.90	0.56	0.22
		AFR breadth of expenditures	123	0.01	0.78	0.17	0.15
		Improvement Standards	124	0.00	0.66	0.47	0.12
		% staffing on direct patient care	122	0.00	0.70	0.19	0.14
		% Spending on Direct Patient Care	123	0.00	4.28	0.24	0.49
	Dependent Variables	Core Exp. (total)	124	0	37,526,080	3,086,200	6,003,790
		Core Expenditures (ln)	123	10.50	17.44	14.14	1.19
		Core Exp. per Capita	124	0.00	129.92	31.38	21.14
		Core FTEs	124	0.00	314.78	30.63	48.17
		Core FTEs per Capita	124	0.00	0.00	0.00	0.00
		Patient Care Exp. (total)	124	0	6,363,373	511,361	1,001,350
		Patient Care Expenditures (ln)	90	7.24	15.67	12.39	1.83
		Patient Care Exp. per Capita	124	0.00	120.72	7.79	15.21
		Patient Care, FTEs	124	0.00	159.54	8.99	17.60
		Patient Care, FTEs per Capita	124	0.00	0.00	0.00	0.00
New Independent Variables		Count of All ODH Grants	124	0.00	6.00	1.56	1.39
	Centrality Measures						
		Non-Redundant Ties	123	0.00	78.08	5.16	8.38
		Closeness Centrality	119	0.31	0.77	0.44	0.06
		Degree Centrality	123	0.00	83.00	7.18	9.20
		Relative Connectivity	123	0.00	1.00	0.12	0.12
	Network Measures	Power	119	1.00	4.00	2.74	0.59
		Value	119	1.00	4.00	2.67	0.59
		Trust	119	1.92	4.00	3.35	0.43
		Reliability	119	1.50	4.00	3.24	0.58

TABLE VIIIb. DESCRIPTIVE STATISTICS

			Less than 195K Population			
			N	Minimum	Maximum	Mean	Std. Deviation
Original Core-Plus Scale Model	Jurisdictional Characteristics	County LHD	75				
		City LHD	26				
		Population Total (Actual)	110	6,459	171,758	51,751	40,513
		Population; Total (Log)	110	8.77	12.05	10.58	0.76
		% population rural	110	0.00	1.00	0.41	0.30
		% Population Non-white	110	0.01	0.51	0.08	0.09
		Households. % non-English speaking	110	0.00	0.09	0.01	0.01
		% population age 65 +	110	0.07	0.22	0.15	0.02
		Per capita income	110	14,996	49,293	22,501	5,242
		% Population Uninsured	110	0.08	0.18	0.10	0.01
		Mds per 100K pop (phys rate)	110	0.00	167.10	55.20	29.52
	Agency Characteristics	NACCHO breadth of coverage	99	2.00	73.00	38.27	12.31
		Naccho % of Services	108	0.00	0.90	0.54	0.22
		AFR breadth of expenditures	109	0.01	0.78	0.18	0.15
		Improvement Standards	110	0.00	0.66	0.47	0.12
		% staffing on direct patient care	108	0.00	0.70	0.20	0.14
		% Spending on Direct Patient Care	109	0.00	4.28	0.26	0.51
	Dependent Variables	Core Exp. (total)	110	0	6,896,706	1,561,300	1,410,550
		Core Expenditures (ln)	109	10.50	15.75	13.88	0.95
		Core Exp. per Capita	110	0.00	129.92	30.93	20.09
		Core FTEs	110	0.00	73.75	18.77	15.13
		Core FTEs per Capita	110	0.00	0.00	0.00	0.00
		Patient Care Exp. (total)	110	0	3,993,227	356,557	603,080
		Patient Care Expenditures (ln)	79	7.24	15.20	12.18	1.79
		Patient Care Exp. per Capita	110	0.00	120.72	8.26	16.01
		Patient Care, FTEs	110	0.00	42.61	6.00	7.49
		Patient Care, FTEs per Capita	110	0.00	0.00	0.00	0.00
New Independent Variables		Count of All ODH Grants	110	0.00	4.00	1.30	1.11
	Centrality Measures	Non-Redundant Ties	109	0.00	78.08	5.22	8.84
		Closeness Centrality	105	0.31	0.77	0.43	0.07
		Degree Centrality	109	0.00	83.00	7.21	9.68
		Relative Connectivity	109	0.00	1.00	0.12	0.13
	Network Measures	Power	105	1.00	4.00	2.69	0.59
		Value	105	1.00	4.00	2.61	0.59
		Trust	105	1.92	4.00	3.34	0.45
		Reliability	105	1.50	4.00	3.21	0.60

TABLE VIIIc. DESCRIPTIVE STATISTICS

			Greater than 195K population				
			N	Minimum	Maximum	Mean	Std. Deviation
Original Core-Plus Scale Model	Jurisdictional Characteristics	County LHD	14.00				
		City LHD	14.00				
		Population Total (Actual)	14	196,731	853,720	416,641	203,085
		Population; Total (Log)	14.00	12.19	13.66	12.84	0.47
		% population rural	14.00	0.00	0.23	0.07	0.08
		% Population Non-white	14.00	0.04	0.59	0.22	0.17
		Households. % non-English speaking	14.00	0.01	0.09	0.02	0.02
		% population age 65 +	14.00	0.09	0.17	0.13	0.03
		Per capita income	14	16,665	36,014	27,603	4,808
		% Population Uninsured	14.00	0.09	0.23	0.11	0.03
		Mds per 100K pop (phys rate)	14.00	41.40	167.10	110.54	37.59
	Agency Characteristics	NACCHO breadth of coverage	14.00	26.00	65.00	45.50	12.24
		Naccho % of Services	14.00	0.43	0.88	0.71	0.14
		AFR breadth of expenditures	14.00	0.03	0.38	0.17	0.11
		Improvement Standards	14.00	0.18	0.65	0.52	0.13
		% staffing on direct patient care	14.00	0.05	0.37	0.17	0.09
		% Spending on Direct Patient Care	14.00	0.00	0.27	0.11	0.10
	Dependent Variables	Core Exp. (total)	14	2,415,658	37,526,080	15,067,000	12,251,600
		Core Expenditures (ln)	14.00	14.70	17.44	16.16	0.94
		Core Exp. per Capita	14.00	9.40	120.76	34.95	28.78
		Core FTEs	14.00	21.18	314.78	123.80	97.46
		Core FTEs per Capita	14.00	0.00	0.00	0.00	0.00
		Patient Care Exp. (total)	14	0	6,363,373	1,727,700	2,154,430
		Patient Care Expenditures (ln)	11.00	11.88	15.67	13.91	1.40
		Patient Care Exp. per Capita	14.00	0.00	17.84	4.07	4.97
		Patient Care, FTEs	14.00	1.82	159.54	32.48	42.33
		Patient Care, FTEs per Capita	14.00	0.00	0.00	0.00	0.00
New Independent Variables		Count of All ODH Grants	14.00	1.00	6.00	3.57	1.79
	Centrality Measures	Non-Redundant Ties	14.00	1.38	11.68	4.65	3.03
		Closeness Centrality	14.00	0.44	0.52	0.46	0.02
		Degree Centrality	14.00	2.00	16.00	6.93	4.14
		Relative Connectivity	14.00	0.04	0.29	0.12	0.07
	Network Measures	Power	14.00	2.67	4.00	3.15	0.37
		Value	14.00	2.39	4.00	3.08	0.42
		Trust	14.00	2.97	3.75	3.42	0.25
		Reliability	14.00	3.00	4.00	3.48	0.32

PARTNER included a variety of qualitative measures of network organization. Though they could be argued to be ordinal variables, they were represented as interval variables in the survey results and can be generally understood to be as such. As a result, they were used in the regression. Additionally, it should be noted that the value that was actually represented was the average score of all respondents and not the individual score (1-4).

Analytical Strategy

Analysis of the relationship between centrality measures and variables in the Bernet and Singh (2013) model were conducted in two distinct waves: the first compared the centrality measures against the other independent variables of the model that are outside of the control of the LHD (primarily population statistics) and the second examined the relationship between centrality and the independent variables and dependent variables within the control of the LHD such as scope of services, expenditures, and staffing. This was done to identify any obvious signs of multicollinearity between the key variables and centrality measures as well as to explore the relationship between the variables outside the regression model. Scatter plots were created for both the log of population as used in the regression model as well as actual population and each of the three measures of centrality (closeness, degree, and non-redundant ties). They were similarly created between each of the dependent variables (expenditures and staffing by clinical and core) and the measures of centrality.

Population and expenditures, which are strongly correlated ($r = .838$, $n = 110$, $p = .000$), show a similar pattern in their relationship to centrality. As the scatter plots presented in Figures 11 and 12 show, there are two characteristics of the scatter plots that define the relationship in the analysis. The first is the obvious floor/ ceiling effect of the centrality measures, i.e. there exists a very clear separation between two sub-groups within the population based on the level of their interaction within the network. This dominates all the scatter plots that included a measure of centrality.

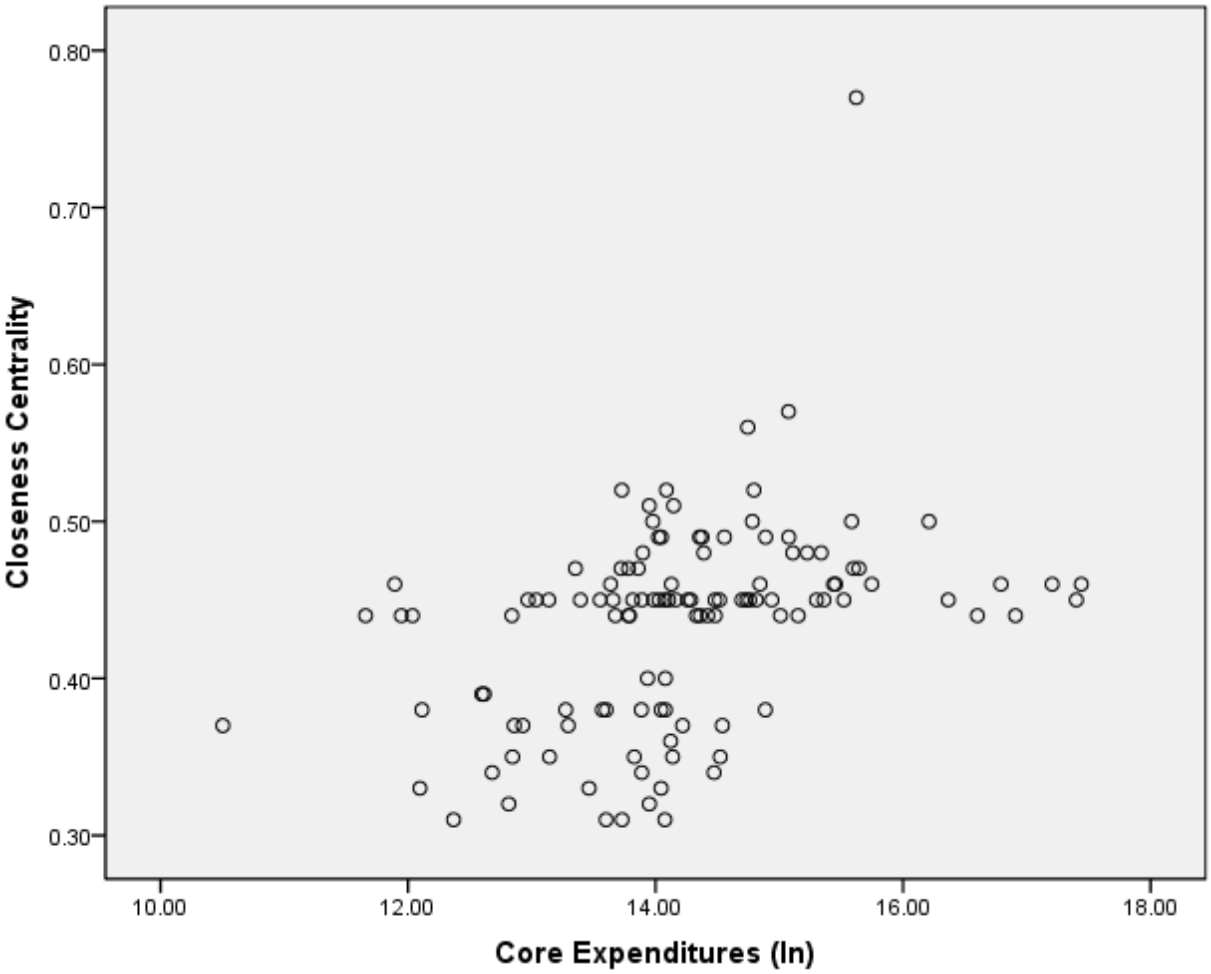


Figure 11. Scatterplot of Core Expenditures with Centrality

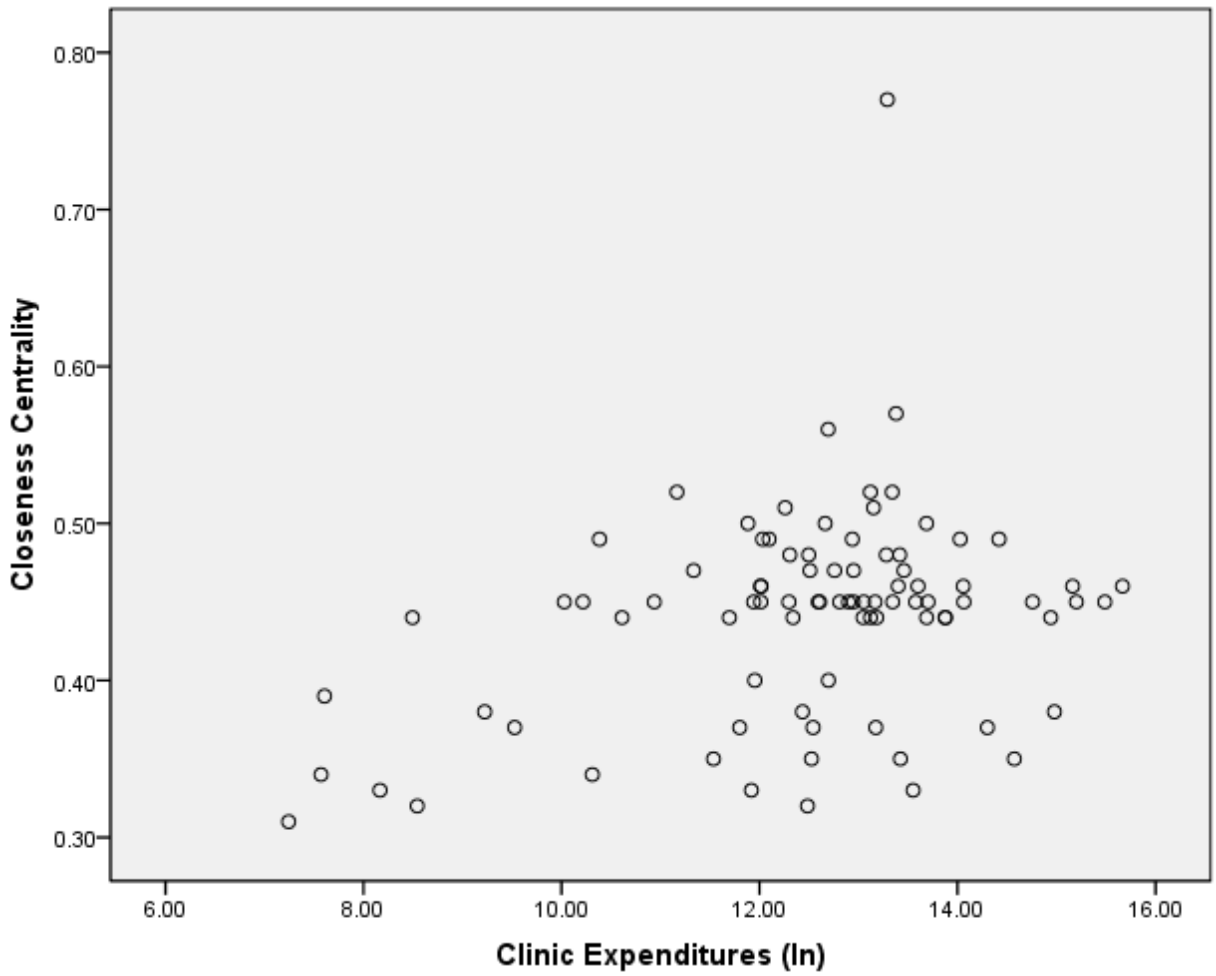


Figure 12. Scatterplot of Clinical Expenditures with Centrality

The second characteristic was the suggestion of a curve in the data, centered near the mean of the population and/or expenditures. As expenditures increase, closeness centrality increases until a threshold after which closeness centrality decreases. In the scatter plot, LHDs on both ends of the jurisdictional size show fewer relationships than the LHDs in the middle of the Graph.

When centrality was plotted against the count of all ODH grants, a similar though less pronounced pattern also emerged with the highest centrality falling to the middle of the grants and the two tails having a distinctly lower centrality score.

TABLES IX and X display the Pearson's correlation coefficients computed to assess the relationship between the centrality measures and both the existing model's independent variables (TABLE IX) and the dependent variables (TABLE X).

The independent variables selected for analysis were based on the study's conceptual model (Figure 1) which suggested a relationship between a decision to share services or partner and an LHD's

scope of services, ability to perform services, its resources, and various population factors outside its control. For the current study, NACCHO breadth of coverage and percent of services acted as good proxies for a jurisdiction's program. Population, as already found in the Bernet and Singh (2013) study, was a significant predictor of a jurisdiction's expenditures and so was also included in the correlation.

Closeness Centrality, a measure of connectivity between a single LHD (node) and all other LHDs within the network, was found to have a low to moderate, positive correlation to all three of the independent variables: NACCHO breadth of services ($r = 0.212$, $n = 110$, $p < .05$), NACCHO % of services ($r = 0.317$, $n = 117$, $p < .01$) and population ($r = 0.354$, $n = 119$, $p < .01$). Closeness Centrality was a good indicator of the influence of a given actor in a network, but was conceptually a poorer proxy for shared services than degree centrality, which examined the direct relationships with other actors in the network.

However, Closeness Centrality ($r = 0.396$, $n = 118$, $p < .01$) had a stronger relationship with the dependent variable, Core Expenditures (ln), than Degree Centrality ($r = 0.219$, $n = 122$, $p < .05$). Value was a measure of how LHDs view the contributions of one another in a relationship. This was considered a good proxy for the value of the shared service. Value had a moderate, positive correlation with both population ($r = 0.266$, $n = 119$, $p = .000$) and a weak, positive correlation with NACCHO % of Services ($r = 0.266$, $n = 117$, $p = .004$).

TABLE IX. CORRELATIONS BETWEEN NETWORK MEASURES AND MODEL IVs.

		Power	Value	Trust	Non-Redundant Ties	Closeness Centrality	Degree Centrality	NACCHO breadth of coverage	Naccho % of Services	Population; Total (Log)	% population rural	% Population Non-white	Households. % non-English speaking	% population age 65 +	Per capita income	% Population Uninsured	Mds per 100K pop (phys rate)	% Spending on Direct Patient Care	Core Expenditures (ln)	Clinic Expenditures (ln)
Power	**Pearson Correlation**		.603**	.535**	.224*	0.137	.242**	.190*	.264**	.401**	-0.165	0.167	0.094	-0.146	0.007	-0.010	.227*	0.160	0.196	0.442
	Sig. (2-tailed)		0.000	0.000	0.014	0.137	0.008	0.046	0.004	0.000	0.073	0.069	0.310	0.112	0.112	0.915	0.013	0.085	0.068	0.000
	N		119	119	119	119	119	110	117	119	119	119	119	119	119	119	119	117	87	118
Value	**Pearson Correlation**			.603**	.234*	0.168	.260**	0.133	.266**	.362**	-0.107	0.130	0.066	-0.104	0.015	0.050	0.148	0.171	.398**	0.151
	Sig. (2-tailed)			0.000	0.010	0.067	0.004	0.167	0.004	0.000	0.245	0.158	0.479	0.261	0.868	0.591	0.109	0.064	0.000	0.162
	N			119	119	119	119	110	117	119	119	119	119	119	119	119	119	118	118	87
Trust	**Pearson Correlation**				0.170	0.170	.193*	-0.020	0.101	0.148	-0.080	-0.111	-0.062	-0.151	0.043	0.032	0.039	0.027	0.152	-0.036
	Sig. (2-tailed)				0.064	0.065	0.035	0.832	0.278	0.108	0.390	0.229	0.504	0.102	0.644	0.731	0.676	0.775	0.100	0.741
	N				119	119	119	110	117	119	119	119	119	119	119	119	119	118	118	87
Non-Red'dant Ties	**Pearson Correlation**					.699**	.991**	0.126	.194*	0.160	0.029	-0.047	0.023	-0.114	0.114	0.008	0.012	-0.075	.219*	0.128
	Sig. (2-tailed)					0.000	0.000	0.187	0.033	0.077	0.748	0.605	0.798	0.209	0.210	0.931	0.897	0.411	0.016	0.230
	N					119	123	112	121	123	123	123	123	123	123	123	123	122	122	90
Closeness Centrality	**Pearson Correlation**						.716**	.212*	.317**	.354**	-0.004	-0.005	0.101	-.249**	.271**	-0.014	0.111	-0.150	.396**	.327**
	Sig. (2-tailed)						0.000	0.026	0.001	0.000	0.963	0.958	0.274	0.006	0.003	0.880	0.228	0.106	0.000	0.002
	N						119	110	117	119	119	119	119	119	119	119	119	118	118	87
Degree Centrality	**Pearson Correlation**							0.116	.215*	0.164	0.070	-0.065	0.016	-0.117	0.096	0.010	-0.001	-0.077	.226*	0.151
	Sig. (2-tailed)							0.224	0.018	0.071	0.443	0.472	0.863	0.196	0.293	0.914	0.995	0.398	0.012	0.155
	N							112	121	123	123	123	123	123	123	123	123	122	122	90
NACCHO breadth of coverage	**Pearson Correlation**								.908**	.372**	-0.088	.233*	0.088	-.276**	0.170	-0.011	.197*	0.004	.457**	.416**
	Sig. (2-tailed)								0.000	0.000	0.357	0.013	0.352	0.003	0.072	0.904	0.036	0.970	0.000	0.000
	N								113	113	113	113	113	113	113	113	113	112	112	83
Naccho % of Services	**Pearson Correlation**									.435**	0.013	0.050	0.061	-.284**	.276**	0.009	.219*	0.043	.458**	.502**
	Sig. (2-tailed)									0.000	0.884	0.581	0.503	0.002	0.002	0.926	0.016	0.638	0.000	0.000
	N									122	122	122	122	122	122	122	122	121	121	89
Population; Total (Log)	**Pearson Correlation**										-.178*	.342**	.261**	-.423**	.350**	0.094	.455**	-0.155	.894**	.379**
	Sig. (2-tailed)										0.048	0.000	0.003	0.000	0.000	0.299	0.000	0.088	0.000	0.000
	N										124	124	124	124	124	124	124	123	123	90
% population rural	**Pearson Correlation**											-.590**	-.261**	0.033	-.208*	-0.007	-.510**	0.119	-0.081	-0.016
	Sig. (2-tailed)											0.000	0.003	0.714	0.021	0.939	0.000	0.192	0.374	0.882
	N											124	124	124	124	124	124	123	123	90
% Population Non-white	**Pearson Correlation**												.433**	-0.169	0.093	-0.009	.655**	-0.155	.384**	.211*
	Sig. (2-tailed)												0.000	0.061	0.304	0.922	0.000	0.087	0.000	0.046
	N												124	124	124	124	124	123	123	90
Households. % non-English speaking	**Pearson Correlation**													-.226*	.254**	.478**	.471**	-0.162	.249**	0.035
	Sig. (2-tailed)													0.012	0.004	0.000	0.000	0.073	0.005	0.745
	N													124	124	124	124	123	123	90
% population age 65 +	**Pearson Correlation**														-0.174	-0.149	-0.167	0.155	-.430**	-.217*
	Sig. (2-tailed)														0.053	0.099	0.064	0.087	0.000	0.040
	N														124	124	124	123	123	90
Per capita income	**Pearson Correlation**															0.141	.469**	-0.042	.218*	.277**
	Sig. (2-tailed)															0.118	0.000	0.647	0.016	0.008
	N															124	124	123	123	90
% Population Uninsured	**Pearson Correlation**																0.052	-0.081	0.058	-0.043
	Sig. (2-tailed)																0.563	0.372	0.522	0.690
	N																124	123	123	90
Mds per 100K pop (phys rate)	**Pearson Correlation**																	-0.156	.405**	.248*
	Sig. (2-tailed)																	0.086	0.000	0.018
	N																	123	123	90
% Spending on Direct Patient Care	**Pearson Correlation**																		-0.120	.361**
	Sig. (2-tailed)																		0.187	0.000
	N																		123	90

***. Correlation is significant at the 0.001 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

TABLE X. CORRELATIONS BETWEEN NETWORK MEASURES & LHD EXPENDITURES

		Power	Value	Trust	Non-Redundant Ties	Closeness Centrality	Degree Centrality	Count of 'Grants	Core Expenditures (ln)	Clinic Expenditures (ln)
Power	**Pearson Correlation**		.879**	.553**	.224*	0.137	.242**	.364**	.412**	0.196
	Sig. (2-tailed)		0.000	0.000	0.014	0.137	0.008	0.000	0.000	0.068
	N		119	119	119	119	119	119	118	87
Value	**Pearson Correlation**			.603**	.234*	0.168	.260**	0.151	.398**	0.151
	Sig. (2-tailed)			0.000	0.010	0.067	0.004	0.162	0.000	0.162
	N			119	119	119	119	87	118	87
Trust	**Pearson Correlation**				0.170	0.170	.193*	0.134	0.152	-0.036
	Sig. (2-tailed)				0.064	0.065	0.035	0.148	0.100	0.741
	N				119	119	119	119	118	87
Non-Redundant Ties	**Pearson Correlation**					.699**	.991**	0.128	.219*	0.128
	Sig. (2-tailed)					0.000	0.000	0.163	0.016	0.230
	N					119	123	123	122	90
Closeness Centrality	**Pearson Correlation**						.716**	.276**	.396**	.327**
	Sig. (2-tailed)						0.000	0.002	0.000	0.002
	N						119	119	118	87
Degree Centrality	**Pearson Correlation**							0.147	.226*	0.151
	Sig. (2-tailed)							0.105	0.012	0.155
	N							123	122	90
Count of ODH Grants	**Pearson Correlation**								.789**	0.525**
	Sig. (2-tailed)								0.000	0.000
	N								123	90
Core Expenditures (ln)	**Pearson Correlation**									.505**
	Sig. (2-tailed)									0.000
	N									90
Clinic Expenditures (ln)	**Pearson Correlation**									
	Sig. (2-tailed)									
	N									

***. Correlation is significant at the 0.001 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

As with the independent variables in TABLE IX, Closeness Centrality was moderately, positively correlated with both core expenditures (r = 0.396, n =118, p = .01) and clinic expenditures (r = 0.327, n = 87, p = .01) while degree centrality was only correlated with core expenditures (r = 0.226, n = 122, p <.05). Closeness Centrality also shared weak or moderate, significant relationships with many of the other independent variables. Conceptually, the relationship between measures of population and NACCHO % of Services or Breadth of Services were important to note.

A new variable, Integrated Arcs, was created from the network data based on the actual count of linkages where the relationship was defined as "integrated" on the PARTNER survey. The variable was created by only counting those arcs, or network interactions, that were defined as 'integrated' on the survey. This excludes casual network ties in order to focus only on those relationships that could be said to approximate shared services. This was correlated against both a listing of independent variables as with Table 2 and the dependent variables. Generally, Integrated Arcs had a weak, in-significant relationship with the dependent variables including Core Expenditures (R^2 = 0.170, N=122, ns) and Clinic Expenditures (R^2 = 0.091, N = 90, ns). Nor was the 'head' (R^2 = 0.167, N = 122, ns) or 'tail' (R^2 = 0.170, N = 122, ns) significantly correlated with Core Expenditures. This variable could have diminished value as a result of the smaller sample.

From both the scatter plots and the correlations, Closeness and Degree Centrality have a moderate, positive relationship with core expenditures (dependent variables) as well as an undefined relationship with several of the independent variables. It seems reasonable to test the regression model with the inclusion of the new variables.

Regressions

Multivariate linear regression was used to analyze the research questions. The base (Core) and expanded (Plus-Scale) models of the Bernet and Singh (2013) study were used as the foundation for the analysis and are represented in TABLES XI and XV along with a comparison of regressions from the revised model. TABLE XI is an initial regression using the various network measures collected from the Partner survey and represents an initial examination of the predictive qualities of the network measures. Bernet and Singh's original regressions were replicated to confirm the authenticity of the data set. All values were similar with the exception of the influence of City on the cost of services. In several of the regressions, it was previously reported that CITY was a predictor of cost and had a negative relationship with core expenditures. In the base model, city was not significant the regression runs were checked against the original results reported by Bernet and Singh (2013). As previously noted, the city variable was adjusted from the original data set due to conflicting information regarding nine of the reported cases.

As with previous studies, the natural log of core and clinical expenditures was used to eliminate the significant differences between small and large health departments. Similarly, log is used for population in the dependent variables.

When adding the new independent variables, block entry was used to test the F-Change value of the new variables against the original model and is reported in TABLES XII-XV

Network Variables

Initially, all variables were entered into the model in blocks corresponding to their conceptual category from the Partner survey. These can be generally thought of as: network connectivity, measures of value of the relationship, and measures of trust. TABLE XI reports only the completed model and not the step-in of each block. TABLE XI also shows the predictive ability of the network measures on expenditures when all LHDs are included as well as when the sample is reduced to LHDs smaller than 195,000.

The reduction in the sample size had little impact on the predictive ability of the models. Closeness Centrality was the strongest predictor in every iteration. Network measures were also more likely to be significant in the models examining Core Spending and less so in the models examining Clinical Spending. This is similar to the base model.

A model was run with the strongest variables, both in terms of predictive ability and conceptual alignment, from the base model and the network measures. Population (B = 0.710, P < .001), NACCHO Breadth of Coverage (B = 0.012, P <.001), Closeness Centrality (B =1.542, P <.05), Power (B = 0.123, ns), and Count of ODH Grants (B =0.234, P <.001) resulted in an overall model fit of an adjusted R^2 = 0.869.

TABLE XI. VARIOUS REGRESSIONS ON CENTRALITY MEASURES

	Unstandardized Coefficients									
	Core Spending, Block Entry			Core Spending (ln), all LHDs				Clinical Expenditures (ln) by LHD		
	A	B	C	<195K	All	Reduced	Best	<195K	All	Reduced
(Constant)	10.811***	7.282***	9.340***	10.244***	8.638***	11.104***	4.593***	8.149**	**7.179****	**8.433*****
Jurisdiction Characteristics										
Population size (log)							.710***			
Core-Plus Scale Measures										
NACCHO breadth of coverage							.012***			
Network Measures										
Integrated Arc (Head)	-0.003	0.009	0.008							
Integrated Arc (Tail)	0	-0.006	-0.04							
Degree Centrality	-0.244	0.029	-0.127							
Closeness Centrality	8.1**	11.142***	10.089***	7.217***	10.948***	3.506***	1.542*	12.049*	14.548**	5.837*
Non-Redundant Ties	0.154	-0.005	0.083	.009	.012			-.110	-.090	
Reliability			.616*	.567*	.646*	-.035		-.351	-.151	
Relative Connectivity	7.074	-5.481	1.154	-1.884	-4.266			5.276	2.184	
Power		.844**	.715**	.412	.701**	.359*	.123	.941	1.043*	0.142
Value		a	a	a	a			a	a	
Trust			a	a	a			a	a	
Openness to Partnering			-0.698*	-.358	-.616*	-.071		-.142	-.410	
Mission Alignment			-0.262	-.262	-.266			-.422	-.468	
Involvement		-0.344	-0.131	-.113	-.139			-.671	-.551	
Contribution		.472*	0.219	.100	.246			.443	.471	
Count of ODH Grants						.574***	.234***			.561***
Run summary										
F	4.176***			5.033***	8.258***	43.781***	144.726***	1.984	2.725**	11.720***
F Change		9.912***	3.003*							
r2	0.184	0.36	0.441	.325	.408	.662	.875	.213	.242	0.298
adjusted r2	0.14	0.307	0.344	.261	.358	.646	.869	.106	.153	0.272
N	118	118	118	104	118	118	109	76	87	87

*** P < 0.001. **P < 0.01. * P < 0.05.

Note: (a) variable excluded due to multicollinearity

Core Expenditures (ln)

The Core Plus Scale model was already an incredibly robust model with nine variables accounting for an adjusted R^2 of .855. In the Core Plus Scale model, population, population non-white, per capita income, and NACCHO % of services were all significant. When two additional variables, Closeness Centrality and Contribution were added, the adjusted R^2 increase slightly to 0.862 (increasing 0.07) was significant. The adjusted r square continued to rise with the addition of Count of ODH Grants ($R^2 = 0.888$) and was significant.

Reduced models

Since several LHDs were found to have zero reported connections, a reduced regression model was created including only those health districts who had a connection. This model also required the elimination of one extreme outlier who reported more than twice the number of network connections as the next highest LHD. The final reduced model included Population (B = 0.920, P < .001), NACCHO Breadth of Coverage (B = 0.015, P < .001), % Staffing on Direct Care (B = 1.305, P < .01), and Closeness Centrality (B = 2.165, P < .05). The resulting linear regression model was found to be significant, F(4, 78) = [105.825], P < .001, with an adjusted R^2 of 0.836. It is interesting to note that the standardized coefficients in the model were similar with the exception of population (Beta = 0.778); Closeness Centrality (Beta = 0.106), NACCHO Breadth of Coverage (Beta = 0.145), and % Staffing on Direct Care (Beta = 0.143). This reinforces the idea that jurisdictional characteristics, i.e. population, have a more profound influence on cost than anything within the control of the district.

When the entire model was reduced to two variables, Count of ODH Grants and Closeness Centrality, using the same dependent (Core Expenditures (ln)), the model was significant with an adjusted R^2 of 0.634 and both of the IVs significant at .001 or less. An interaction effect was not found to be significant.

Similarly, a model was run to examine the effects of only NACCHO % Services and Closeness Centrality on Core expenditures. As with the previous stripped model, this two variable model was also significant with an adjusted R^2 of 0.270 and both IVs being significant at .001 or less. The interaction effect in this model was found to be significant and negated the main effect of both IVs.

Given the limited data set, an interaction effect using the central mean was not used, rather an interaction effect of the product of (X1) X2 = X1X2 was used in the regression.

Core Expenditures, Actual

Using actual core expenditures as the dependent variable changed the original model in several ways but also changes the impact of the revised model. In the original model, core expenditures resulted in an adjusted R^2 of 0.704 with the predictors City, Population (log), Percent Population Rural, Percent

Population Nonwhite, and Per Capita Income.($f = 24.149$, $p < .001$). It should be noted that Per Capita was a negative predictor in this model ($b = -209.859$, $p < .05$). The addition of Closeness Centrality was not significant (F Change = 0.321, $P < .573$), however, when Count of ODH Grants was added, the adjusted R^2 increases to 0.736 and per capita dropped out.

Core expenditures, per Capita

Using per capita of core spending changed the model in several ways. First the adjusted R^2 of the base model was 0.432 with Population (log) and Percent Staffing on Direct Care being the only variables from the Core Plus Scale remaining significant. As with the previous models, Closeness Centrality and Count of ODH Grants remained significant.

Summary of Core expenditures, (<195k population)

Regardless of the variations of the dependent variable, Core Expenditures, Population (log), Closeness Centrality, and Count of ODH Grants were significant predictors in the various iterations of the regression model.

TABLE XII. REGRESSION OF CORE SPENDING

	Unstandardized Coefficients							
	Core Spending (ln), all LHDs				Only cases (jurisdictions) with less than 195,000 population			
	Bernet & Singh	New		Per Capita	Bernet & Singh	New		Per Capita
(Constant)	4.253***	3.559**	5.501***	88.575	6.360***	5.589***	7.028***	148.431**
Jurisdiction Characteristics	(B)							
Type of agency =city	-.192	-.094	.033	14.467	-.533	-.397	-.179	9.358
Type of agency =county								
Population size (log)	.879***	.846***	.692***	-10.642**	.769***	.741***	.625***	-13.480***
Percent pop. rural	.381	.475	.388	16.447	-.127	.037	.073	7.900
Percent pop. nonwhite	2.408**	2.344**	1.693*	54.859	1.404	.1446	1.161	25.284
Percent pop. non-English speaking	1.843	1.225	2.311	59.907	5.314	4.223	3.797	118.181
Percent pop. 65+ years old (%)	-2.241	-1.701	-3.426	-81.950	-3.725	-3.197	-4.546	-99.357
Percent pop. uninsured (%)	-2.652	-2.645	-2.377	-46.942	-4.455	-4.412	-5.147	-224.762
Physicians per 100,000 population	-.001	.000	-.001	-.057	-.001	-.001	.000	-.033
Core-Plus Scale Measures								
NACCHO breadth of coverage	.011**	.011**	.009*	.211	.008	.008	.005	.116
% Staffing on direct care	1.352***	1.189***	.990**	30.913*	1.245***	1.120	.989	28.271*
Network Measures								
Closeness Centrality		**1.457***	**1.528***	**73.984****		**1.491**	**1.438***	**69.347****
Contribution		**.115**	**.030**	**.539**		**.093**	**0.023**	**.788**
Count of ODH Grants			**.209*****	**9.803*****			**.235*****	**11.391*****
Run summary								
F	63.847***	56.820***	66.000***	7.264***	29.494***	26.224***	31.566***	5.417***
F Change		3.728*	22.421***			2.949	20.378***	
r2	.868	.878	.901	.501	.780	.795	0.837	.468
adjusted r2	.855	.862	.888	.432	.754	.765	0.81	.382
N	108	108	108	108	94	94	94	94

*** P < 0.001. **P < 0.01. * P < 0.05.

CORE FTEs Associated with Grants and Population

The base model had an adjusted R^2 of 0.646, with the additional variables, the adjusted R^2 rose to .688. Unlike with core expenditures, only the Count of ODH Grants was found to be a significant predictor in the model (b =12.155, p <.001). The addition of Count of ODH Grant caused NACCHO Breadth of Services to drop out of the model.

As with previous models, the Per Capita FTEs were also examined. From the base model the adjusted R^2 rose 0.323 from a starting adjusted R^2 of 0.189. Population remained a strong predictor as did NACCHO breadth of coverage, population nonwhite, and % staffing on direct patient care until Count of ODH grants was added. When count of grants was added, % staffing on direct patient care dropped out of the model. The final model with all variables added found population to remain a strong predictor, as was Percent Population Non-white. In the Per Capita model, Closeness Centrality was also a significant predictor (b =0.001, P <.01) as was Count of ODH Grants (b =0.000, P <.001).

TABLE XIII. REGRESSION OF CORE FTE

	Unstandardized Coefficients							
	Core Services FTE, all LHDs				Only cases (jurisdictions) with less than 195,000 population			
	Bernet & Singh	New		Per Capita	Bernet & Singh	New		Per Capita
(Constant)	-547.025***	-552.688***	-439.621***	.002***	-102.429**	-119.361***	-91.936**	.002***
Jurisdiction Characteristics								
Type of agency =city	47.801*	49.903**	57.298***	0.000	-16.318*	-13.630*	-9.457	0.000
Population size (log)	41.011***	40.237***	31.297***	.000***	10.798***	10.139***	7.925***	.000***
Percent pop. rural	58.062**	59.884**	54.810**	0.000	-20.882*	-17.650*	-16.977*	0.000
Percent pop. nonwhite	165.193**	159.849**	121.979*	.001*	10.635	11.665	6.242	0.001
Percent pop. non-English speaking	-568.059*	-559.637*	-496.404*	-.001	-10.311	-35.868	-43.984	-0.001
Percent pop. 65+ years old (%)	210.205	211.206	110.784	0.001	73.000	85.715	59.985	0.001
Percent pop. uninsured (%)	270.588	240.533	256.178	0.000	-18.545	-10.622	-24.642	-0.002
Physicians per 100,000 population	0.007	0.014	0.002	0.000	0.000	0.012	0.020	0.000
Core-Plus Scale Measures								
NACCHO breadth of coverage	.606*	.622*	0.468	-.000*	.251**	.248**	.195*	0.000
% Staffing on direct care	22.914	16.956	5.345	.000	5.785	3.658	.071	0.000
Network Measures								
Closeness Centrality		8.458	12.542	.001**		36.204*	4.489***	.001**
Contribution		5.045	0.082	0.000		1.398		0.000
Count of ODH Grants			12.155***	.000***				.000***
Run summary								
F	20.557***	17.087***	19.169***	9.691***	17.073***	15.619***	18.717***	37.654***
F Change		.596	14.682***			3.405*	17.562***	
r2	.679	.683	.726	.573	.673	.698	.753	0.421
adjusted r2	.646	.643	.688	.514	.633	.654	.712	0.335
N	108	108	108	108	94	94	94	94

*** P < 0.001. **P < 0.01. * P < 0.05.

CLINIC EXPENDITURES

The base models original R^2 was 0.232 using the same predictors that resulted in such a high adjusted R^2 in the Core Expenditures model. Neither Closeness Centrality nor Count of ODH Grants was found to be significant. It is worth noting that the case counts for these runs drops to a total of 80 due to the previously described lack of clinical services provided by several LHDs.

Clinical Expenditures per Capita Associated with Resource Contribution

The base model in the per capita dependent variable was a poor adjusted R^2 of 0.001 and was not significant. In the full model, the adjusted R^2 was slightly better at 0.091, but only Contribution was significant (b = 3.583, P < .05).

Patient Care FTEs, Network Measures are poor predictors

In the base model, Population and % of Population(s) Rural and Non-white, and NACCHO Breadth of Coverage were significant predictors (adjusted R^2 = 0.377, F = 8.332, P <.001). While neither network measure impacts the model, the addition of Count of ODH Grants (B = 0.001, P <.05) did cause Percent Population Non-white to drop out of the model. This could be the result of grant processes which target at-risk populations or high population centers though the correlation between the two is weak (R = 0.194, n= 124, P < .05). There is a stronger, negative correlation between Count of ODH Grants and % Population rural (R = 1.590, N =124, P < .01).

Patient Care FTEs per capita Associated with Population & Grants

As we have seen with previous models, the complete model had a very small adjusted R^2 (0.137) with only Population (log) (B =-0.00008, P <.05) and Count of All ODH Grants (B =0.00004, P <.05) as significant predictors.

TABLE XIV. REGRESSION OF CLINICAL SPENDING

	Unstandardized Coefficients						
	All cases, Clinical Expenditures (ln) by LHD				Only cases (jurisdictions) with less than 195,000 population		
	Bernet & Singh	New		Per Capita	Bernet & Singh	New	
(Constant)	15.600**	13.6622*	14.962*	46.722	18.798**	15.958*	16.165*
Jurisdiction Characteristics							
Type of agency =city	-1.742	2.066	.299	2.192	-2.340	-1.736	-.342
Population size (log)	-.174	-.175	-.303	-4.307	-.404	-.299	-.333
Percent pop. rural	-1.298	-1.031	-1.081	3.482	-1.688	-.875	.096
Percent pop. nonwhite	7.761*	7.451*	5.069	.098	4.659	3.864	3.527
Percent pop. non-English speaking	-3.519	-3.995	-7.219	2.520	3.460	.997	-6.661
Percent pop. 65+ years old (%)	-7.154	-4.706	-7.476	23.900	-.802	2.909	.279
Percent pop. uninsured (%)	-8.690	-10.145	-6.593	-72.531	-25.872	-37.926	-44.933
Physicians per 100,000 population	-.002	-.001	-.001	-.010	.005	.006	.008
Core-Plus Scale Measures							
NACCHO breadth of coverage	.031*	.031*	.025	.135	.034*	.038*	.029
Network Measures							
Closeness Centrality		2.066	2.785	-14.993		1.422	2.583
Contribution		.324	.671	3.583*		.434	.292
Count of ODH Grants			.145	2.192			.515*
Run summary							
F	3.684***	3.172**	3.139***	1.908*	2.296*	2.177*	2.488*
F Change		.911	2.175			.036	.052*
r2	.318	.336	.356	.191	.256	.292	.344
adjusted r2	.232	.230	.243	.091	.145	.158	.206
N	81	81	81	110	70	70	70

*** P < 0.001. **P < 0.01. * P < 0.05.

TABLE XV. REGRESSION OF CLINICAL FTEs

	Unstandardized Coefficients						
	All cases, Total FTEs per Jurisdiction				Only cases (jurisdictions) with less than 195,000 population		
	Bernet & Singh	New		Per Capita	Bernet & Singh	New	
(Constant)	-148.373***	-152.669***	-104.435*	.001	-16.970	-22.335	-13.95
Jurisdiction Characteristics							
Type of agency =city	15.554	8.319	19.858*		-6.626	-5.745	-4.329
Population size (log)	10.035***	9.619***	5.808*	-.00008*	1.973	1.804	1.117
Percent pop. rural	23.119*	23.846*	21.730*	.000	-5.607	-4.538	-4.329
Percent pop. nonwhite	63.110*	61.334*	45.220	.000	10.464	11.015	9.377
Percent pop. non-English speaking	-237.945	-236.417	-202.750	.000	-5.795	-12.838	-14.937
Percent pop. 65+ years old (%)	59.837	61.497	18.122	.000	28.776	32.428	24.406
Percent pop. uninsured (%)	101.561	91.716	97.664	.000	-24.835	-23.452	-28.06
Physicians per 100,000 population	.006	.009	.004	.000	-.024	-.021	-0.018
Core-Plus Scale Measures							
NACCHO breadth of coverage	.315*	.313*	.240*	.000	.134*	.133*	0.115
Network Measures							
Closeness Centrality		8.319	8.976	.000		10.022	9.553
Contribution		2.156	-.178	.000		.530	0.081
Count of ODH Grants			.001*	.00004*			1.45
Run summary							
F	8.332***	6.863***	8.057***	2.442**	3.835***	3.221***	3.294***
F Change		.571	12.409***			.612	3.183
r2	.429	.435	.499	.232	.289	.297	.323
adjusted r2	.377	.372	.437	.137	.212	.205	.225
N	110	110	110	110	96	96	96

*** P < 0.001. **P < 0.01. * P < 0.05.

Quadratic term

From the various scatterplots, network association, such as degree centrality or non-redundant ties, appeared to be potentially nonlinear in their relationship with Core Expenditures (4). Employing a quadratic term in the clinical expenditures model did not prove significant nor gain in the overall adjusted R^2 of the model. Neither did the block entry show a significance in the f-change. This was also the case with other measures of clinical spending and a square of the non-redundant ties.

However, a regression of Core FTEs with the squared term of Non-Redundant Ties was found to be significant. The Core-Plus Scale model was run with the addition of the Non-redundant Ties, the Square of Non-Redundant Ties and the Cube of Non-Redundant Ties. These variables were statistically significantly predictors of Core FTEs $F(12,97) = 5.451$, $p < .000$, $R^2 = ..403$, adjusted $R^2 = 0.329$. The two additional variables, non-redundant ties ($B = .00001$, $t() = 2.66$, $p < .01$) and the square of non-redundant ties ($B = -0.0000008$, $t() = -2.132$, $p < .05$), contributed to the overall predictive ability of the model (adjusted R^2 increased from 0.291 to 0.329).

Since the X^2 model found both Non-Redundant Ties and its square to be significant, positive predictors of Core Spending (ln), the model demonstrated a net effect greater than a linear increase as the number of Non-Redundant Ties increased on the cost of Core Expenditures.

TABLE XVI. REGRESSION OF CORE SPENDING, CURVILINEAR RELATIONSHIPS

	Unstandardized Coefficients			
	Bernet & Singh	x	New X^2	ODH
(Constant)	4.325***	4.161***	3.761**	5.827***
Jurisdiction Characteristics				
Type of agency =city	-0.265	-0.218	-0.122	.016
Type of agency =county				
Population size (log)	.870***	.872***	.895***	.724***
Percent pop. rural	.392	.446	0.498	.417
Percent pop. nonwhite	2.643***	2.697***	2.474**	1.750*
Percent pop. non-English speaking	1.356	1.011	0.078	1.827
Percent pop. 65+ years old (%)	-2.394	-2.093	-2.066	-3.854*
Percent pop. uninsured (%)	-2.17	-1.953	-1.695	-2.210
Physicians per 100,000 population	-0.001	-0.001	.000	.000
Core-Plus Scale Measures				
NACCHO breadth of coverage	.011**	.010*	.010*	.008*
% Staffing on direct care	1.331***	1.326***	1.326***	1.063***
Network Measures				
Non-Redundant Ties		.010*	.032**	.025*
Square Non-Redundant Ties			.000*	.000
Count of ODH Grants				.211***
Run summary				
F	65.932***	62.423***	59.275***	70.106***
F Change		4.434*	3.954*	24.890***
r2	0.869	0.875	0.88	0.905
adjusted r2	0.856	0.861	0.865	.892
N	110	110	110	110

*** P < 0.001. **P < 0.01. * P < 0.05.

IVc. Network Analysis Article

Formatted per the requirements of the Journal of Public Health Management and Practice

A Network Analysis of Ohio's Local Health Departments: Efforts at Cross Jurisdictional Sharing

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Abstract

Context

For several years, Ohio's local health departments have been increasingly encouraged by state policy, lack of funding, or simple need to engage in shared services agreements or regionalized programming. This has created a complex network of relationships between jurisdictions that LHDs can draw upon in providing services to their jurisdictions.

Objective

To examine the breadth, intensity, and nature of Ohio's LHDs inter-organizational relationships with particular focus on the type of public health services shared by LHDs and through that to inform future efforts at shared services.

Design

A network analysis of Ohio's LHDs was conducted in the fall of 2014 using PARTNER, a web-based network analysis survey.

Participants

While all of Ohio's 124 public health officers were invited to participate, 55 (44%) participated in the survey. From those scores, a network model representing all 124 LHDs was created.

Results

The LHD network displayed a high degree of centralization (62.2%); twenty-six (26) LHDs were central actors within the network, indicated by a degree centrality score greater than 10 (the average degree centrality of all members was 7.14). The most common programs shared by LHDs were Emergency Preparedness and Epidemiology followed by Clinical Services—this corresponds to previous research which found a significant, positive relationship between grant funded programs (like emergency preparedness and epidemiology) and core expenditures.

Conclusions

Ohio's LHDs have formed many integrated relationships to share resources/ knowledge and to assure the provision of services within Ohio's various local public health jurisdictions. Most of the shared services appear linked to grant funded programs.

BACKGROUND

There is growing, national, concern regarding the efficiency, and by extension the performance, of local public health services. The emphasis on 'down-sizing' of political subdivisions ignores the impact and power of cross-jurisdictional sharing (CJS), the process by which LHDs share services, programs, or resources in fulfilling their obligations. When properly applied and deliberate, CJS balances the benefits of "mid-sizing" (avoiding consolidation that is either too small or too large and retaining local control over the majority of decisions, the key benefit of local public health) (Kaufman, 2010).

Cross-jurisdictional interactions or sharing (CJS) among local health departments (LHDs) can be easily understood within the framework of inter-organizational networks. Such a network can be defined as "a set of autonomous organizations that come together to reach goals that none of them can reach separately"(5). While large LHDs are structurally equipped to meet performance standards with specialized staffing and resources, small and medium sized jurisdictions (less than 100,000) rarely maintain the specialized staffing roles required by these standards. In fact as noted above small jurisdictions attempting to compete with larger jurisdictions are at a structural disadvantage (6). However, smaller jurisdictions may find common purpose with their peers and may engage in a complex, voluntary network of relationships to meet standards that individually they would fail to do.

Networks that form organically-- that is to say through common need, purpose, or interest-- are stronger and more likely to generate their desired results (5, 7, 8). For instance, networks that form around common programs are more likely to increase access to and sustain engagement in those programs(9). Voluntary participation in such networks also tends to strengthen 'communities of interest' Ultimately, to be successful, the network must be locally driven and local units must believe that collaboration is positive for their community and that locals retain some measure of autonomy (8). Drawing from social networks research, the homophily effect (10), or a preference for interacting with similar entities, suggests that commonality in culture and demographics could also influence the nature of organizational networks.

Historically, there has been an openness among LHDs to collaborate in the public system (11, 12). Certainly organizational networks have been used as a means to expand services. In a meta-analysis of LHDs, (13) one of the most consistent findings across studies was that the larger the population that the agency served, the more likely the agency will provide the "Ten Essential Public Health Services."(14) This tends to suggest that expanding the agency's population base, by offering services jointly with another agency, would enable agencies to improve their ability to deliver the ten essential services to that population. Certainly experience has found that collaboration between districts tends to be in those areas most associated with population-based public health, i.e. assessment, assurance, and advocacy (15).

In summary, successful network partnerships or CJS involve a shared mission among multiple entities (5), tend to be more effective when they develop organically (8), and are more likely to succeed when measures of success are clear and a financial incentive is provided(16). Ohio's decentralized and expansive local health departments provide an opportunity to examine the practical application of 'organically grown' networks designed to meet increasing state mandates for services, emergency preparedness, and financial efficiency.

For this study, a public health network is one which is connected by one or more specific types of interdependent relationships such as the exchange or provision of finances, services or knowledge (Wasserman, 1994; McPherson et al.., 2001). For local health departments, these can be construed to include expertise specific to public health such as epidemiology, clinical services, or plumbing inspections.

Conceptual Framework

Due to increasing state performance demands and scope of services, Ohio's local health departments have engaged in expansive organizational networks to share resources around specialized functions. These networks are made possible by a high degree of trust and a sense of shared mission among the members of the network.

METHODS

Unit of analysis

The primary unit of analysis is the local health department (LHD). Surveys were sent to the public health officers in each of Ohio's 125 local governmental public health organizations, or LDHs;.55 responses (44%) were returned. The links between LHDs were then mapped to form the local public health network.

In Ohio, public health is governed and administered by an independently appointed Board of Health in a decentralized local governmental public health system (17). Ohio law allows for three different types of health districts—city, general, and combined (ORC 3709.01). For all but a few, general districts are co-terminus with county borders. Of the 124 LHDs in Ohio, 37 are independently operated city districts. Overall, 58% of LHDs in Ohio serve small population sizes (<50,000), 39% serve medium or large population sizes (50,000-499,999), and 3% serve very large population sizes (500,000+) (3). Of the 55 surveys completed, 10 of 29 possible (34.5%) were from small LHDs (less than 25,000), 33 of 67 possible (49.3%) from medium sized LHDs (25,001-100,000), 12 of 24 (50.0%) from large jurisdictions (100,001-500,000) and 2 of 4 (50.0%) possible from mega districts (500,001+). The differences between observed and expected was not significant.

Survey Instrument

Data was collected through PARTNER, a web-based network analysis survey tool. While PARTNER has a fully defined set of questions that examine the core attributes of network analysis such as relationship, power, and trust, it does not generate data specific to the sharing of public health programs. To attempt

to capture this, the questionnaire was modified to ask about several services known to be shared between jurisdictions through previous research conducted by the Association of Ohio Health Commissioners(11). From that research, the top four services in descending order were: (1) Epidemiology services for outbreaks and trending (53%); (2) HIV testing (46%); (3) Lead assessment (44%); and (4) STD testing and treatment (40%). In all, 57% of LHDs self-identified as engaging in current CJS with others local health departments (11).

A subset of services were selected for inclusion in the PARTNER survey. To increase the likelihood that respondents were engaged in one of the services, only those services that more than 25% of the respondents in the previous study indicated were already being shared were considered for possible inclusion. (6) The final selection attempted to balance clinical and core services (3), and to avoid over-representation among grant funded programs. The final grouping consisted of three clinical services that are shared, three population based services, and two regulatory or environmental health services. The last category was the least likely to be shared according to the survey results. Since regulatory authority is a core function of local public health and that authority is vested with the local health officer, this is not surprising.

Since the survey represented minimal risk and asked questions of public officials in their official capacity, the University of Illinois at Chicago IRB granted the request for exemption on 02 September 2014, Research Protocol # 2014-0668.

In order to test the reliability of the network survey, it was given to the nine district directors of the state Association of Ohio Health Commissioners for review and comment. Consensus was gained from the directors and the survey was presented to the Board of the state association (AOHC) for approval and dissemination to the membership.

Sampling

The entire population of eligible respondents, Ohio's 124 health officers or administrators of local health districts, were invited to participate. An email list of all current contacts was downloaded from the Ohio Department of Health's website and cross checked against a list from the Association of Ohio Health Commissioners. If a discrepancy was found between the two lists, the initial contact was sent to the AOHC contact list first.

The survey was advertised in both the AOHC weekly newsletter and through the directors at regional meetings during the four weeks that the survey was open. An initial email request was sent 09 September 2014 giving advanced notice that an email request to participate would be sent. The actual invitation from PARTNER with the login information was sent 12 September 2014. Two additional follow up emails were sent to remind the directors to participate: the first on 30 September 2014 and the last on 13 October 2014. In addition, the District Directors for AOHC also made individual reminders to some of the district members encouraging them to participate in the survey.

While all 124 local health commissioners were invited to participate, only fifty-five (44%) LHDs responded to the survey. Of those, chi-square tests were performed by region and city-county status to

determine whether the resulting sample was, if not expansive, proportional to the total population of local health departments. The chi-square tests found no significant variation between respondents and non-respondents in any region, $X^2(4, N = 124) = 7.293$, $p = .121$, or city-county, $X^2(1, N = 124) = 1.984$, $p = .159$.

Though the majority of LHDs did not complete the survey as requested, the fifty-five who completed the survey, in whole or in part, created a representative sample along two key dimensions of importance to the study (city/ county and region). Other studies have shown that missing data may be possible to overcome through triangulation of linked respondents (18) or by estimating responses using various imputation methods. However such methods have limitations of their own and were deemed a less optimal track for the current study (19).

It should be noted that although the entire population of LHDs did not respond, the nature of the network analysis gave every participating LHD an opportunity to indicate whether a link (arc) existed between their agency (the respondent) and another health district. While this creates limitations in the direction of the relationships from a traditional analysis standpoint, it still created some image as to how all the health departments in a region may or may not have interactions with a particular department even if that department failed to complete the survey. Consequently, partial data is available for 124 of the 124 possible respondents even with only fifty-five completing the survey.

Network analysis

The network analysis was built using PARTNER. In addition to the new questions, PARTNER also provided several numeric characteristics of both the entire LHD network and the individual LHD network scores.

Individual network scores were scored and evaluated followed by examinations of the types of interactions within the entire network based on frequency and type (cooperative, coordinated, or integrated). Results were then examined within the various regions of the association.

Once the network analysis was completed the results were shared with the district directors for review and comment. As with similar studies, a combination of survey results and key informant interviews was used to develop the final network model (20). The intent was to create a practical understanding of how the organizational data was reflected in practice. The directors affirmed that the network analysis was an accurate portrayal of both the association as a whole and their individual districts.

RESULTS

Network Analysis

PARTNER includes multiple dimensions for investigating the network. While all of these were reviewed, several were dismissed as being of limited value either because responses were very uniform (possible respondent bias) or because the low respondent sample diminished the reliability of the responses (for instance direction of services provided).

While PARTNER allows network maps to be drawn based on frequency of interaction from daily to less than annually, most of the maps used in the analysis focused on daily or weekly integrated activities. Since the focus of the study was on shared services, it was believed that this routine level of interaction and perception of the interaction as *integrated* in nature would approximate shared services.

In the analysis, the nature of the relationship between members of the network was summarized in three ways:

- Cooperative Activities: involves exchanging information, attending meetings together, and offering resources to PARTNERs (Example: Informs other programs of RFP release) ;
- Coordinated Activities: Include cooperative activities in addition to intentional efforts to enhance each other's capacity for the mutual benefit of programs. (Example: Separate grant programs utilizing shared administrative processes, policy templates, or forms to deliverables.);
- Integrated Activities: In addition to cooperative and coordinated activities, this is the act of using commonalities to create a unified center of knowledge and programming that supports work in related content areas. (Example: Developing and utilizing shared priorities for funding effective prevention strategies. Funding pools may be combined.);

For reference, Figure 1 illustrates all LHDs in the network having at least some interaction, even less than annually, up to and including daily contact. In all the network maps, the district or region to which the LHD belongs was indicated by shape. Only a single LHD was not connected to the network in such a broad representation. The high level of interaction was not surprising given statutory requirements for participation in two annual conferences endorsed by the state department of health, but managed by the state association.

[Insert Figure 1. Network Map of interactions between LHDs occurring once a year or less]

Even when network maps were generated at the district level of the association, all LHDs indicated at least one cooperative relationship within the district membership. However

the LHD network shows a high degree of centralization (62.2%) indicating a network with several key, interconnected members and the majority of members having fewer relationships within the network. This is also apparent in the range and standard deviation of the centrality measures. Twenty-six LHDs had a degree centrality ≥ 10. These represent central actors within the network. Of the 124 LHDs indicated in the network, five (5) had degree centrality scores approximating zero (0). Four were small, less than 25,000 population, city health districts and one was a county health district. It is possible that the unconnected LHDs do have connections with other LHDs who did not complete the survey. Even so, it is likely indicative of a very little network activity on the part of the five districts.

It was clear from the respondents that there was a group of LHDs that had significant and routine interactions, often indicating that they were engaged in financial or staffing relationships. Figure 2 compares LHDs that indicated ‘daily interaction’ versus LHDs indicating an ‘integrated’ relationship.

[Insert *Figure 13. Comparison between LHD 'daily interaction' and 'integrated relationship'*]

In examining individual network scores, it was found that highly centralized members did not hold any specific position of trust or influence over other members. For instance, the highest ranking LHD for centrality ranked 18th for overall value the organization brought to the network and 47th for overall trust. The second highest ranking centrality scored 13th for Value and 7th for Trust. This pattern was repeated several times with a highly embedded member of the network scoring lower than expected in Trust and Value. It became apparent that the number of connections did not readily translate into a perception of higher trust or overall value. Descriptive statistics are provided in TABLE I for the LHDs in the network.

[Insert TABLE I. DESCRIPTIVE STATISTICS FOR INDIVIDUAL NETWORK SCORES]

The low Relative Connectivity score also points to a network that was loosely connected with a relatively few members deriving significant benefit through its membership.

Qualitative Measures

While the connectivity of LHDs was well represented through the data collection process, getting a complete sense of the qualitative measures was more difficult to ascertain due to the low survey participation. As a result, much of the information collected by the PARTNER painted an incomplete picture of the Ohio LHD network. This was particularly true of questions that speak to individual LHD participation or experience within the network.

[Insert TABLE II. SERVICES PROVIDED OR RECEIVED BETWEEN LHDS, 2014]

Table 2 provides the responses to what services are currently being shared between Ohio's LHDs in 2014. The answers are presented in the order asked in the survey. From the survey, Emergency Preparedness was the most commonly shared program followed by Epidemiology. Both were grant funded programs with an emphasis on CJS. Emergency preparedness is highlighted as one of the key outcomes as would be expected among Ohio's LHDs given that most of the collaboration around the state is centered on the emergency preparedness and is explicitly funded in a manner that requires collaborative network activities. This was a theme that would carry through each of the four qualitative questions.

The link between 'Improved Communication' and 'Improved Resource/ Knowledge Sharing' may also have significant overlap with the 'Increased Emergency Preparedness' but it is not immediately clear from the responses.

Lastly, the respondents did feel that the collaboration either had resulted or would result in 'Improved Health Outcomes'.

Both for programs received and provided, health education and clinical programs are the next most frequent responses. In Ohio, the state Department of Health provides many grants in these two areas that either directly require or emphasize regional approaches.

Most LHD respondents indicated that they viewed the collaborative from the core mission of, 'improving health outcomes' (28.8% of responses) followed closely by improved resource sharing (19.2% of responses), as would be seen in cooperative networks. The high percentage of respondents indicating 'Increased Emergency Response' (17.3% of responses) was also not unexpected given earlier responses to what programs are shared.

Generally, respondents felt that collaborative efforts were successful with 94% reporting somewhat to very successful. This is not surprising given that jurisdictions have invested significant resources in their partnerships and would be unlikely to view such expenditures harshly. However, it is worth nothing that the scores were evenly distributed across all three categories of successful. So even if there was a respondent bias in answers, more than 2/3 still chose to mark the collaborations as successful or very successful. This is likely indicative in the value that participants saw in their network collaborations.

In examining the factors that contribute to the success of the collaboration, answers were uniformly distributed across all possible responses (11%-13%) with two standouts: 'Exchanging info. Knowledge' (18.4% of responses) and 'Sharing resources' (16.8% of responses) which had slightly higher response rates. This fits with the most commonly observed aspect of the LHD network, that most of the current relationships are cooperative in nature rather than the more coordinated or integrated style of networks. LHDs also highly valued 'Exchanging Info/ Knowledge' above other categories, which would fit with the cooperative exchange perspective of the relationships.

DISCUSSION

Unfortunately, a state public health crisis occurred soon after the survey was released and likely impacted the return rate for the survey. This likely impacted survey return rates. However, even with the limited response, the survey collected many data points that proved useful in describing Ohio's LHD network.

Low density and high centralization among Ohio's LHDs speaks to the uneven nature of the integrated relationships within Ohio. The resulting picture is a network with several key actors, with average interactions and a subsequent sense of influences, but high levels of trust between the members. The high level of trust is a requisite of positive CJS. Certainly, the network map (Figure 1) speaks to the enormous number of integrated programs already in operation in Ohio. It was not possible from the data collected to determine whether the embeddedness of an actor was related to their role in a given relationship or the value derived.

The relationships that scored strongly were unsurprising given the nature of public health funding in Ohio. The conceptual framework of the study suggested that CJS was a product of rising performance standards and among the key programs shared was epidemiology and emergency preparedness: two requirements of LHDs since 9-11 attacks and subsequent grant funding. Other services, such as clinical

services, may also speak to block grant funding from the state Department of Health and the increasing need to regionalize those programs..

It is also worth noting that while many of the cliques formed around integrated services, not all included a financing aspect. From the current study, it was not clear if this is a limitation of the sample size. Further iterations of this work should examine the role of multiplexity, LHDs that link cliques, to see if those organizations differ from other members of the network.

The value of the study was in the attempt to investigate CJS as a function of networks. Further study should focus on the temporality of CJS within a network, i.e. does the CJS arise from a valued existing network or does the network value arise from a successful CJS? More importantly, the incorporation of network, CJS, into studies examining the quality of service delivery and the financing of local public health is critical. Pressure for further regionalization and consolidation needs to consider the efforts that already exist and why they exist in contemplating the next iteration of local public health governance.

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TABLE I. DESCRIPTIVE STATISTICS FOR INDIVIDUAL NETWORK SCORES					
		AVG	**MIN**	**MAX**	**SD**
CENTRALITY/CONNECTIVITY/ REDUNDANCY	**Degree Centrality (max 124):** *# of connections to other members of the network*	7.14	0.00	83.00	9.15
	Non-Redundant Ties: *shows the number of non-redundant ties in relation to the other members that each organization is connected too.*	5.14	0.00	78.08	8.33
	Closeness Centrality: *Measures how far each member is from other members of the network in terms of # of links between each member. A high score (close to 1) indicates members who have the shortest 'distance' between all other members.*	0.44	0.31	0.77	0.06
	Relative Connectivity: *Based on measures of value, trust, and # of connections to others, the connectivity score indicates the level of benefit an organization receives as a network member, in relation to the member with the highest level of benefit (100%).*	0.12	0.00	1.00	0.12
Value(1-4)	**Overall Value** (1-4): *an average of the ranking given by all other members for that organization along three dimensions: influence, involvement and contribution. Scale of 1-4.*	2.67	1.00	4.00	0.12
	Power/Influence (1-4)	2.75	1.00	4.00	0.59
	Level of Involvement (1-4)	2.77	1.00	4.00	0.66
	Resource Contribution (1-4)	2.5	1.00	4.00	0.71
TRUST (1-4)	**Total Trust** (1-4): *an average of the ranking given by all other members for that organization along three dimensions: reliability, support of mission, and open to discussion. Scale of 1-4.*	3.35	1.92	4.00	0.43
	Reliability (1-4)	3.24	1.50	4.00	0.58
	In Support of Mission (1-4)	3.40	2.00	4.00	0.41
	Open to Discussion (1-4)	3.40	1.75	4.00	0.53
N = 124					

TABLE II. SERVICES PROVIDED OR RECEIVED BETWEEN LHDS, 2014				
Please indicate what programs your LHD [BLANK] as a member of this local health department collaborative (choose as many as apply).	**Received**		**Provide**	
	Count	% (%*)	Count	% (%*)
STD Testing & Treatment	10	21.7 (7)	11	26.2(7)
TB Services	5	10.9 (3)	7	16.7(4)
Epidemiology Services for Outbreaks and Trending	28	60.9 (19)	21	50(13)
Emergency Preparedness	30	65.2 (20)	32	76.2(20)
Community Health Assessment Services	12	26.1 (8)	10	23.8(6)
Commercial / Residential Plumbing	6	13.0 (4)	8	19.1(6)
Lead Abatement	2	4.4 (1)	7	16.7(4)
Other Environmental Programs	13	28.3 (9)	13	31.0(8)
Other clinical/ public health nursing programs	18	39.1 (12)	19	45.2(12)
Other Health Education/ Health Promotion Programs	14	30.4(9)	19	45.2(12)
Other Public Health Programs not otherwise categorized	12	26.1(8)	13	31.0(8)
**Percentage of responding LHDs (Percentage of all responses)*				

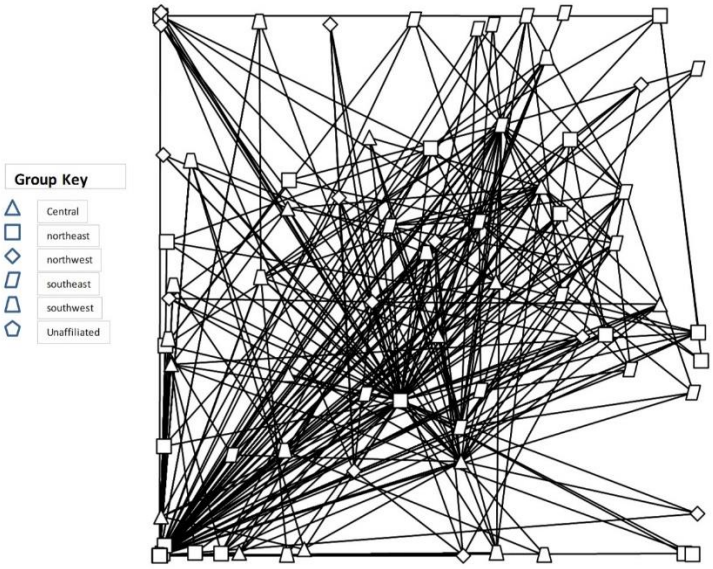

Figure 14. Network Map of interactions between LHDs occurring once a year or less.

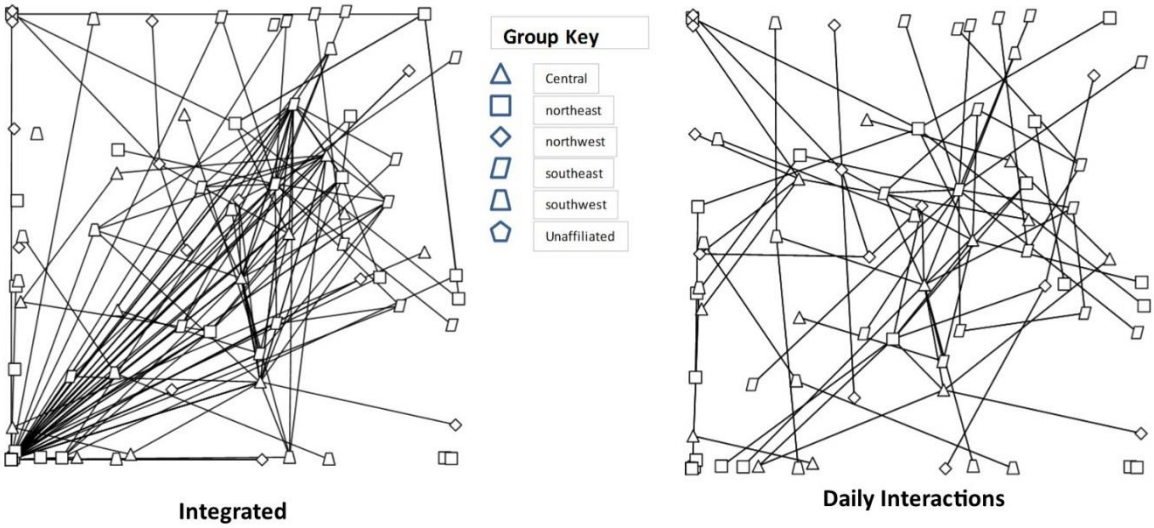

Figure 15. Comparison between LHD network 'daily interaction' and 'integrated relationship'

IVd. Regression Article

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Impact of Organizational Networks on the Cost of Core Services in Ohio's Local Health Departments

Orcena, J.E., Petros, M., Bernet, P.M.

Abstract

The study investigates the relationship between organizational network linkages amongst Ohio's 124 Local Health Jurisdictions and the cost of the delivery of core services. The study used PARTNER web-survey to determine the degree of interactions between LHDs. Forty-four percent (55 of 124 eligible) of Ohio's health officers responded to the survey.

The results demonstrated that higher levels of network interaction are associated with higher costs of delivering core services. A linear regression was conducted to predict core expenditures based on closeness centrality. A significant regression was found $F(1,116) = 21.557$, $P < .001$ with an $R^2 = 0.157$.

Closeness centrality and value (of network) was also included in the Core Plus-Scale model original proposed by Bernet and Singh in 2013. The addition of Closeness centrality and Value caused a significant increase in the adjusted R^2 of the entire model but found that the more central a local health department was within its network, the greater its expenditures on core services.

Introduction

While the issue of financing of local public health continues to be kicked down the proverbial road, many studies have linked population size, breadth of service, and ability to meet standards to the cost of delivery (1-4). What is often missing in the discussion is the role of LHD networks in the delivery of local services and the cost that such network relationships entail.

Previous regression analysis using data collected by the National Profile of Local Public Health Agencies, found that per capita public health spending decreases as the population reaches approximately 100,000 covered lives. However, further investigation by Bernet & Singh (2013) using Annual Financial Reporting data in Ohio, did not find the L-shaped relationship discovered in previous research. Instead, the duo reported the relationship between per capita expense and population in Ohio was linear. They posited that Ohio had reached an, "efficiency frontier". Their final model identified population characteristics, particularly size, breadth of services offered, and percent of staff dedicated to clinical care as key influencers on core services spending in Ohio.

This study expands the understanding of the impact of LHD networks on the cost of providing core services among Ohio's local health departments.

Methods

Data for the social network analysis was collected through a survey of Ohio's 124 local health commissioners using PARTNER, a web based network analysis tool. Of the 124 eligible, fifty-five (44%) of LHDs responded in whole or in part to the PARTNER survey. PARTNER provided closeness centrality, degree centrality, and various qualitative measures for all of Ohio's LHDs. The network data collection generated scores for all of the LHDs in Ohio regardless of participation as long as one member of any given dyad participated in the survey. Closeness centrality was chosen to represent network centrality in the final model. Closeness is a measure of the degree to which an individual is near all other individuals

in a network. It is the inverse of the sum of the shortest distances between each node and every other node in the network.

Closeness centrality was added to the Bernet and Singh(2) Core Plus-Scale model. This was used as the base model with various other network measures tested through block entry into the multiple regression analysis.

As with previous studies, the natural log of core expenditures and the log of population was used to normalize the significant differences between small and large health departments in both jurisdiction size and funding.

Chi-square tests found no significant variation in respondents from expected in any category of region, $X^2(4, N = 124) = 7.293$, $p = 0.121$, or city-county, $X^2(1, N = 124) = 1.984$, $p = 0.159$. The respondents provided a representative sample of LHDs in Ohio, which also increased the likelihood of capturing relationships.

The University of Illinois at Chicago, Institutional Review Board granted a request for exemption (Research Protocol # 2014-0668) for the collection of the network analysis. Additional data was provided by the NACCHO Profile of LHDs, Ohio's Annual Financial Report of LHDs, and the US Census.

Results

Closeness centrality was found to have a low to moderate, positive correlation to three of the independent variables, NACCHO breadth of services ($r = 0.212$, $n = 110$, $p < .05$), NACCHO % of services ($r = 0.317$, $n = 117$, $p < .01$), and population ($r = 0.354$, $n = 119$, $p < .01$), and moderate, positive relationship with the dependent variable, core expenditures ($r = 0.396$, $n = 118$, $p < .01$). In all four cases, the more central an LHD was to the network, the more services they performed from the NACCHO list of services, the higher the population served by the LHD, and the more the agency spent on core services. Count of ODH Grants was also found to have a strong correlation with Core Expenditures ($r = 0.789$, $n = 123$, $p < .01$) so that an LHD with a greater number of grants from the state department of health was more likely to spend more on core services.

A multiple regression was conducted examining the influence of the network measures on the Core Plus-Scale model. The results are presented in Table 1.

[Insert Table 1]

Additionally, several LHDs were found to have zero reported connections, a reduced sample regression model was created including only those health districts who had at least one confirmed direct connection as either the head or tail of an arc. This model also required the elimination of one extreme outlier who reported more than twice the number of network connections as the next highest LHD. The final reduced model included Population ($B = 0.920$, $P < .001$), NACCHO Breadth of Coverage ($B = .015$, $P < .001$), % Staffing on Direct Care ($B = 1.305$, $P < .01$), and Closeness centrality ($B = 2.165$, $P < .05$). The resulting linear regression model was found to be significant, $F(4, 78) = [105.825]$, $P < .001$, with an adjusted R^2 of 0.836. Though not presented in the table, it is interesting to note that the standardized coefficients in the model are similar (Closeness centrality, Beta = 0.106; NACCHO Breadth of Coverage, Beta = 0.145; and % Staffing on Direct Care, Beta = 0.143) with the exception of Population (Beta =

0.778). This reinforces the supposition that jurisdictional characteristics, i.e. population, have a more profound influence on cost than anything within the control of the district.

Since 50% of Ohio's population is found within 14 large health jurisdictions, a reduced sample of LHDs with jurisdictions less than 195,000 was also examined. The reduction in the sample size had little impact on the predictive ability of the models though closeness centrality was found to be a predictor of higher spending on core services only when the number of grants received by an LHD was included in the model.

Regardless of the variations to the DV, Core Expenditures, Population (log), Closeness centrality, and Count of ODH Grants were significant predictors of increased spending on core services by an LHD.

Implications

The growing discussion on the use of shared service or consolidation of LHDs is predicated on the belief that such actions create an automatic cost savings for districts, but typically fail to account for the cost of those relationships. The current study builds upon the previous work of Bernet and Singh(2) which found that size of jurisdiction is the strongest predictor of cost of service delivery. In the new model, network relationships and the number of grants were also predictors of the cost of core services.

The study did not address the nature of the relationships, only their extent. Consequently, it is unknown whether network relationships acted as a cost-containment mechanism or increased the ability of an LHD to provide services. However, the addition of the new variables improved the accuracy of the model and demonstrated that the more central an LHD is to the network, the higher their expenses on core services.

Summary Box

Research has found evidence that size of jurisdiction has an impact on both the cost of providing public health services and the quality of those services. In this study, the impact of network relationships on those costs is explored.

The study found that increasing embeddedness within the network of LHDs, i.e. relationships up to and including shared services were related to a net increase in the cost of the delivery of core services.

What is not clear from the study is whether the costs are less than would have been experienced if the LHD had not engaged in those relationships. From the study, it is clear that interagency relationships increase the cost of the delivery of core services, but still unknown is whether over time, they bend the cost curve downwards.

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TABLE I. REGRESSION OF BERNET-SINGH CORE SPENDING MODEL WITH CLOSENESS CENTRALITY

		Unstandardized Coefficients			Unstandardized Coefficients		
		Core Spending (ln), all LHDs			Only cases (jurisdictions) with less than 195,000 population		
		Bernet & Singh	New		Bernet & Singh	New	
(Constant)		4.253***	3.559**	5.501***	6.360***	5.589***	7.028***
Jurisdiction Characteristics							
Type of agency =city		-.192	-.094	.033	-.533	-.397	-.179
Type of agency =county							
Population size (log)		.879***	.846***	.692***	.769***	.741***	.625***
Percent pop. rural		.381	.475	.388	-.127	.037	.073
Percent pop. nonwhite		2.408**	2.344**	1.693*	1.404	.1446	1.161
Percent pop. non-English speaking		1.843	1.225	2.311	5.314	4.223	3.797
Percent pop. 65+ years old (%)		-2.241	-1.701	-3.426	-3.725	-3.197	-4.546
Percent pop. uninsured (%)		-2.652	-2.645	-2.377	-4.455	-4.412	-5.147
Physicians per 100,000 population		-.001	.000	-.001	-.001	-.001	.000
Core-Plus Scale Measures							
NACCHO breadth of coverage		.011**	.011**	.009*	.008	.008	.005
% Staffing on direct care		1.352***	1.189***	.990**	1.245***	1.120	.989
Network Measures							
Closeness centrality			**1.457***	**1.528***		**1.491**	**1.438***
Contribution			.115	.030		.093	0.023
Count of ODH Grants				**.209*****			**.235*****
Run summary							
	F	63.847***	56.820***	66.000***	29.494***	26.224***	31.566***
	F Change		3.728*	22.421***		2.949	20.378***
	r2	.868	.878	.901	.780	.795	0.837
	adjusted r2	.855	.862	.888	.754	.765	0.81
	N	108	108	108	94	94	94

*** P < 0.001. **P < 0.01. * P < 0.05.

V. Discussion

This study attempted to look at cross-jurisdictional sharing (CJS) as a predictor of the cost to provide core services based on the Bernet & Singh Core-Plus Scale model. The value of Bernet's & Singh's model was that it accounted for jurisdictional factors, such as type and size, as well as performance and spending on clinical services. The addition of CJS or network data provided a new dimension to their study as well as providing insight into the nature of CJS in Ohio.

Low density and high centralization among Ohio's LHDs connections speaks to the uneven nature of the integrated relationships within Ohio. The resulting picture was a network with several key actors, with average interactions and a subsequent sense of influences, but high levels of trust between the members. The high level of trust is a requisite of positive CJS. Certainly, the network map (Figure 1) speaks to the enormous number of integrated programs already in operation in Ohio.

The relationships that scored strongly were unsurprising given the nature of public health funding in Ohio. The conceptual framework of the study suggested that CJS was a product of rising performance standards and among the key programs shared was epidemiology and emergency preparedness: two requirements of LHDs since 9-11 attacks and subsequent grant funding. Other services, such as clinical services, may also speak to block grant funding from the state Department of Health.

It is also worth noting that while many of the cliques formed around integrated services, not all included a financing aspect. From the current study, it was not clear if this is a limitation of the sample size.

The study suffered greatly because of the small sample. Though representative, the lack of input into the qualitative measures affected the validity and reliability of both the role of cliques and the nature of services being shared. While data on overall network interaction was possible, the more detailed information, such as integration was harder to support. Greater participation would have made it possible to better describe the direction of CJS within LHDs and their subsequent impact on expenditures. Regardless, the incorporation of network data on cost analysis led to some surprising suggestions.

What was also highlighted and reinforced was the idea that LHDs approach CJS differently. Scatterplots of Core and Centrality clearly showed LHDs at either end of the plots, those LHDs that are either in very small or very large jurisdictions, had fewer recognized partners and interactions than LHDs who are centered around the mode of population sizes. This finding may support the premise that small LHDs may not engage in CJS because they have few resources or interest in partnering while large LHDs have sufficient scale to make CJS unnecessary. It could be theorized that a growing jurisdiction, or LHDs, may reach a threshold-- or tipping point--where partnering becomes desirable and has value sufficient to warrant engagement. Antithetically, the same calculation could be conducted for jurisdictions at the

opposite end of the scale and partnering diminishing as the size of jurisdiction increases. At some point, the complexity of the jurisdiction making it easier to focus internally with partners than externally with other jurisdictions. It should be possible to ascribe a cost to that engagement though it is beyond the capacity of this study to do so.

Count of ODH grants proved an interesting variable. Many of the grants included were regional in lower population areas or centralized around Metropolitan Statistical Areas (MSA). As a revenue source, it was not surprising that this variable would be a strong predictor of expenditures, but in the study it was also shown to increase core expenditures. This may be explained by the reality that the most prolific grant issued to local health departments supports emergency preparedness and epidemiology. This suggests that even grant funding that is siloed has overlaps or supports core services. It should be acknowledged that some grants are more inclined to support this assertion, such as dollars for emergency preparedness, so it may be worthy of further investigation and isolation of these indicators in future research. Unfortunately this result probably points to the very lean funding that Ohio public health currently receives. To have LHDs so linked with population and a single grant is likely indicative of the lack of discretionary funding to Ohio's LHDs.

The funding and staffing of grants also brings forward the issue of scalability. The current system creates a high per capita cost in smaller district relative to their larger brethren because grants oftentimes set minimum standards for their staffing and operation. For instance, many grants require 1 FTE staffing regardless of jurisdiction size. This creates an efficacy paradox, the goal of grants is to efficiently target health priorities in communities with short-term boost in resources to improve the overall state population. However, the management and minimum grant requirements often results in smaller districts with a full time staff person assigned to a grant program regardless of need. This may create more opportunities for success than in larger districts but at a significantly higher cost. The local impact may be more, but the value per dollar and impact to the entire population's health is less.

Va. Recommendations

Of specific interest were the roles of key LHDs that link multiple cliques (multiplexity). By comparison, in a 2010 study of the employee networks of 11 LHDs by Merril et al., measurements included: 1) density as ratio of links present versus total possible; 2) centralization as the difference between the total number of links to and from all pairs of employees divided by the maximum possible sum of differences for all employees; 3) complexity as equal to the ratio of links present versus total number of possible links in the employee to employees networks; 4) clustering coefficient as equal to the average proportion of links between each employee and his or her direct neighbors divided by the number

of links that could possibly exist between them. The report also used a silo index SI = (I – E)/ (E+I) where E was the number of external links and I is the number of internal links. The silo index may be used to determine the role of linchpin LHDs, i.e. those that bridge multiple cliques.

While this study did not examine the role of multiplexity, it seems likely that in a highly centralized system such as Ohio's cost of core services would be impacted in those districts with connectivity outside of their region. It may also be that total resources, and not expenditures, would also be impacted.

Though this study focused on expenditures, the impact of CJS may lie more in the realm of total resources than in core expenditures. Financial distress within local health department is impacted a multitude of factors. Given the focus on local funding in Ohio, this individualization may have a significant impact, i.e. the response to funding shortages in core programs. This examination may be supported by the data which suggested that CJS was centered on grant programs and that a high number of grants was linked with more expenditures. Given that local government in Ohio can only allocate and spend based on resources, it would be interesting to examine how CJS was impacting the gathering of resources versus expenditures. The assumption would be that the two are linked but future research would need to examine the relationship in detail. To accomplish this, a future study would need to examine temporal causality. If CJS is sought as a means to contain cost while maintaining or improving services delivery, a snapshot of data (such as this cross-sectional study) would not uncover it.

The value of the study is the attempt to investigate CJS as a function of networks. Further study should focus on the temporality of CJS within a network, e.g. does the CJS arise from a valued existing network or does the network value arise from a successful CJS? More importantly, the incorporation of network, CJS, into studies examining the quality of service delivery and the financing of local public health is critical. Pressure for further regionalization and consolidation needs to consider the efforts that already exist and why they exist in contemplating the next iteration of local public health governance.

Vb. Conclusion & Leadership Implications

The study made it clear that organizational relationships, as a proxy for CJS, have an impact on health department spending. What was not clear was whether that impact was justified from either a performance or cost-containment perspective.

There are three key items that this study provided for public health leadership:

1) Social Network Analysis (SNA) is tool that policy makers can use to understand the impact of Cross Jurisdictional Sharing on meeting core or foundational services across multiple jurisdictions;
2) Shared services and partnering are predictors of the cost of the delivery of service;

3) Data that SNA provides should be included in models examining the cost of delivering core services.

The qualitative data received through PARTNER demonstrated the generally positive nature of LHD partnerships and the belief that those partnerships were improving public health outcomes. PARTNER, through the modified questions, also provided a context in which to view the nature of the interactions. It was clear that most, though not all, of the interactions were centered on grant funded activities or emergency preparedness (also a grant funded activity). Why do LHDs in Ohio interact? The simple answer was, "To exchange information and further emergency preparedness activities".

As discussed in the results, measures of centrality were positively correlated with both breadth of services and core expenditures. For health officers, the decision to enter into a relationship with another jurisdiction carries with it both the hope of expanding service but it also brings a cost.

The growing discussion on the use of shared service or consolidation of LHDs is predicated on the belief that such actions create an automatic cost savings for districts and the tax payers they represent. The current study builds upon the previous work of Bernet and Singh (2013) which found evidence that size of jurisdiction is the strongest predictor of cost of service delivery. Unfortunately for CJS supporters, in the new model, shared services was also a predictor of increasing cost. For policymakers this should act as a cautionary tale that bigger is not necessarily better or cheaper and the research would seem to suggest that policymakers would be ill-advised to make decisions on the financing of public health services based solely on the size of a jurisdiction.

VI. Limitations

The study was limited by the lack of temporal causality regarding the independent variables, i.e. did the network growth act as a cost-containment mechanism and increase the ability of an LHD to provide services or did the cost of core expenditures increase concomitantly with improved/ expanding core services and network growth? A future research project looking at the rate of change for expenditures versus centrality would provide a better image of the relationship between centrality and expenditures.

The financial data used in the study (AFR) is often criticized for the lack of uniformity of reporting and so it may suffer from some imprecision but still represents the best available data. The Ohio Department of Health has been working to improve the collection of data so future studies should have a clearer picture of expenditures in Ohio by LHDs. Similarly, data gathered in the PARTNER survey had several limitations because of incomplete reporting. Though the qualitative data provided excellent context for examining the regression analysis, a future study on this topic would be well-served to use a

scaled-down survey that focused more on the point-to-point interaction of LHDs. Since this is less an evaluation of the individual than the network, the level of precision sacrificed would be off-set by the validity of the aggregate data.

Appendix A: Recommendations from the AOHC *Futures* Committee

1. All Ohioans, regardless of where they live, should have access to the Core Public Health Services described in the Ohio Minimum Package of Local Public Health Services.
2. All LHDs should have access to the skills and resources that make up the Foundational Capabilities in order to effectively support the core services.
3. The Ohio Minimum Package of Local Public Health Services should be used to guide any future changes in funding, governance, capacity building, and quality improvement.
4. All LHDs should become eligible for PHAB accreditation.
5. LHDs that meet Minimum Public Health Package standards should be prioritized for grant funding in their jurisdiction.
6. The biennial LHD Health Improvement Standards reported to ODH via the Ohio Profile Performance Database should serve as the platform for assessing LHD provision of the Minimum Package. The PPD may need to be updated periodically to capture the core public health services and foundational capabilities.
7. AOHC supports a review of current laws and regulations to determine if/where mandates might be revised or eliminated to repurpose existing funds and advocate for elimination of mandates that do not align with the Minimum Package of Public Health Services.
8. Decisions about the jurisdictional structure of local public health in Ohio should be based upon LHD ability to efficiently and effectively provide the Minimum Package of Public Health Services. Additional factors to consider:

    - population size served by the LHD
    - number of jurisdictions within a county, and
    - local geographic, political, and financial conditions. (see structure diagram and checklist)

9. All LHDs should assess:

    - Their ability to provide the Minimum Package of Public Health Services,
    - The potential impact of cross-jurisdictional sharing (CJS) or consolidation on their ability to provide those services, and
    - The feasibility of and local conditions for CJS or consolidation.

10. Most LHDs, regardless of size, may benefit from CJS. However, LHDs serving populations of <100,000 in particular may benefit from pursuing CJS or consolidation to ensure adequate capacity to provide the Minimum Package.
11. LHDs in counties with multiple LHDs should consider the feasibility of voluntary consolidation.
12. Statutory barriers to voluntary multi-jurisdictional consolidation and cross-jurisdictional sharing should be removed, such as allowing for:

    - Multi-county levy authority, and
    - Consolidation of non-contiguous cities or counties, and
    - Addressing other barriers identified in feasibility analyses

13. All LHDs should have adequate funding to maintain the Minimum Package of Public Health Services. AOHC should continue the work of the PHF Financing Workgroup to identify cost estimates for the Minimum Package (Core Services and Foundational Capabilities) by November 2012.
14. ODH and LHDs should work together to shift the focus from managing fragmented program silos and funding streams toward improving and coordinating state and local organizational capacity to effectively deliver the Minimum Package.
15. AOHC should advocate for block grants or direct contracts when possible so that communities can implement programs based on health assessment priorities.
16. AOHC should work to assure that local health departments are able to obtain fair reimbursement from public and private payers for eligible services (includes efforts to streamline insurance credentialing).
17. AOHC should explore new mechanisms for improving the stability and sustainability of federal, state, and local funding, such as:

    - Dedicated percentage of inside millage in lieu of local levies,
    - Standardized cost methodology to establish fees for programs where no explicit fee-setting authority currently exists,
    - Increasing Local Health Department Support to LHDs to support Foundational Capabilities,
    - Excise taxes (e.g., tobacco, sugar-sweetened beverages, medical transactions), and
    - Integrated health care delivery reimbursement.

18. AOHC should seek funds to support feasibility assessments, transition planning, and incentives necessary for LHDs to implement the new framework (such as submitting a proposal to the RWJF Center for Sharing Public Health Services grant program).

19. AOHC should convene a meeting with state health policy leaders to formally present and discuss the recommendations of the Public Health *Futures* final report and to collaboratively plan strategies and action steps to advance forward progress toward the vision for the future.

Appendix B: PARTNER Modified Survey

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7	**Hybrid** [You can modify wording of the question but the responses will be the same as responses for question #6]	**Which is this local health department collaborative 's most important outcome?**	**Health education services, health literacy, educational resources**	**Improved/expanded clinical services to the community**	**Reduction of Health Disparities**	**Improved Resource Sharing**	**Increased Emergency Preparedness**	**New Sources of Data**	**Community Support**	**Public Awareness**	**Policy, law and/or regulation**	**Improved Health Outcomes**	**Improved communication**		
8	**Yes** [You can modify wording of the question and the responses]	**How successful has this local health department collaborative been at reaching its goals?**	**Not Successful**	**Somewhat Successful**	**Successful**	**Very Successful**	**Completely Successful**								
9	**Yes** [You can modify wording of the question and the responses]	**What aspects of collaboration contribute to this success? (Choose all that apply)**	**Bringing together diverse stakeholders**	**Meeting regularly**	**Exchanging info/knowledge**	**Sharing resources**	**Informal relationships created**	**Collective decision-making**	**Having a shared mission, goals**						
10	**Hybrid** [You can modify the question language however, respondents will choose from the list of organization long names uploaded on the respondent list]	**From the list, select organizations/programs/departments with which you have an established relationship (either formal or informal). In subsequent questions you will be asked about your relationships with these organizations/programs/departments in the context of this local health department collaborative.**													
11	**Yes** [You can modify wording of the question and the responses]	**How frequently does your LHD work with this LHD on issues related to this local health department collaborative's goals?**	**Never/We only interact on issues unrelated to the collaborative**	**Once a year or less**	**About once a quarter**	**About once a month**	**Every week**	**Every day**							
12	**Yes** [You can modify wording of the question and the responses]	**What kinds of activities does your relationship with this LHD entail [note: the responses increase in level of collaboration]?**	**None**	**Cooperative Activities: involves exchanging information, attending meetings together, and offering resources to partners (Example: Informs other programs of RFP release)**	**Coordinated Activities: include cooperative activities in addition to intentional efforts to enhance each other's capacity for the mutual benefit of programs. (Example: Separate grant programs utilizing shared administrative processes, policy templates, or forms to deliverables.)**	**Integrated Activities: In addition to cooperative and coordinated activities, this is the act of using commonalities to create a unified center of knowledge and programming that supports work in related content areas. (Example: Developing and utilizing shared priorities for funding effective prevention strategies. Funding pools may be combined.)**								

13	**No** [You can modify wording of the questions to be customized for your collaborative but we recommend maintaining the workding of the question and the responses]	**How valuable is this LHD's power and influence to achieving the overall mission of this local health department collaborative? "Power/Influence: The LHD holds a prominent position in the community of Local Health Departments by being a respected entity/ having influence, known success as a change agent, showing leadership, etc.**	**Not at all**	**A small amount**	**A fair amount**	**A great deal**										
14	**No** [You can modify wording of the questions to be customized for your collaborative but we recommend maintaining the workding of the question and the responses]	**How valuable is this LHD's level of involvement to achieving the overall mission of this local health department collaborative? "Level of Involvement: The LHD is strongly committed and active in the partnership and gets things done.**	**Not at all**	**A small amount**	**A fair amount**	**A great deal**										
15	**No** [You can modify wording of the questions to be customized for your collaborative but we recommend maintaining the workding of the question and the responses]	**resource contribution to achieving the overall mission of this local health department collaborative? "Contributing Resources: The LHD brings resources to the partnership like funding, information, or other resources.**	**Not at all**	**A small amount**	**A fair amount**	**A great deal**										
16	**No** [You can modify wording of the questions to be customized for your collaborative but we recommend maintaining the workding of the question and the responses]	**How reliable is the LHD? "Reliable: this organization/prgoram/department is reliable in terms of following through on commitments.**	**Not at all**	**A small amount**	**A fair amount**	**A great deal**										
17	**No** [You can modify wording of the questions to be customized for your collaborative but we recommend maintaining the workding of the question and the responses]	**To what extent does the LHD share a mission with this collaborative of of Local Health Departments's mission and goals? "Mission Congruence: this LHD shares a common vision of the end goal of what working together should accomplish.**	**Not at all**	**A small amount**	**A fair amount**	**A great deal**										
18	**No** [You can modify wording of the questions to be customized for your collaborative but we recommend maintaining the workding of the question and the responses]	**How open to discussion is the LHD? "Open to Discussion: this LHD is willing to engage in frank, open and civil discussion (especially when disagreement exists). The LHD is willing to consider a variety of viewpoints and talk together (rather than at each other). You are able to communicate with this LHD in an open, trusting manner.**	**Not at all**	**A small amount**	**A fair amount**	**A great deal**										

Q#	Modifable [explanation]	Question													
1	No	Please select your LHD from the list:	[choose from list]												
2	Yes	What is your job title?	[open ended]												
3	**Hybrid** [You can use any text you want, but the answer must be numerical]	[removed]	[numeric response only]												
4	**Yes** [You can modify wording of the question and the responses]	Please indicate what your LHD contributes to any local health department collaboratives (choose as many as apply).	Direct Funding (through a contract for service or similar mechanism)	In-Kind Resources (e.g., meeting space, equipment)	Paid Staff (who work on behalf of the other jurisdiction even if employed by your agency)	Specific Public Health Program (either directly to jurisdiction or in-directly through LHD)	Data Resources including data sets, collection and analysis	Info/ Feedback	Specific Public Health Expertise	Expertise Other Than in Public Health	Community Connections	Fiscal Management (e.g. acting as fiscal/ administrative agent)	Facilitation/Leadership	Advocacy	IT/web resources (e.g. server space, web site development, social media)
5	**Hybrid** [You can modify wording of the question but the responses will be the same as responses for question #4]	What is your organization's most important contribution to these local health department collaboratives (choose as many as apply).	Direct Funding (through a contract for service or similar mechanism)	In-Kind Resources (e.g., meeting space, equipment)	Paid Staff (who work on behalf of the other jurisdiction even if employed by your agency)	Specific Public Health Program (either directly to jurisdiction or in-directly through LHD)	Data Resources including data sets, collection and analysis	Info/ Feedback	Specific Public Health Expertise	Expertise Other Than in Public Health	Community Connections	Fiscal Management (e.g. acting as fiscal agent)	Facilitation/Leadership	Advocacy	IT/web resources (e.g. server space, web site development, social media)
6	**Yes** [You can modify wording of the question and the responses]	Outcomes of to this local health department collaborative's work include (or could potentially include): (choose all that apply).	Health education services, health literacy, educational resources	Improved/expanded clinical services to the community	Reduction of Health Disparities	Improved Resource/ Knowledge Sharing	Increased Emergency Preparedness	New Sources of Data	Community Support	Public Awareness	Policy, law and/or regulation	Improved Health Outcomes	Improved communication		

Appendix C: IRB Application for Exemption

UNIVERSITY OF ILLINOIS
AT CHICAGO

Office for the Protection of Research Subjects (OPRS)
Office of the Vice Chancellor for Research (MC 672)
203 Administrative Office Building
1737 West Polk Street
Chicago, Illinois 60612-7227

Exemption Granted
September 3, 2014

Jason Orcena, MA, BA
Public Health
940 Londan Ave, Suite 1100
Marysville, OH 43040
Phone: (740) 361-4155 / Fax: (937) 645-3047

RE: Research Protocol # 2014-0668
"For a Few Dollars More: The Case for Cross-Jurisdictional Sharing in Ohio's Local Health Departments"

Sponsor(s): None

Upon receipt, please submit – via amendment – a copy of the signed data use agreement with Ohio RAPHI for the use of the modified NACCHO dataset.

Dear Mr. Orcena:

Your Claim of Exemption was reviewed on September 2, 2014 and it was determined that your research meets the criteria for exemption. You may now begin your research.

Exemption Period:	September 2, 2014 – September 2, 2017
Performance Site:	UIC
Subject Population:	Adult (18+ years) subjects only
Number of Subjects:	125

The specific exemption category under 45 CFR 46.101(b) is:
(2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

You are reminded that investigators whose research involving human subjects is determined to be exempt from the federal regulations for the protection of human subjects still have responsibilities for the ethical conduct of the research under state law and UIC policy. Please be aware of the following UIC policies and responsibilities for investigators:

Amendments You are responsible for reporting any amendments to your research protocol that may affect the determination of the exemption and may result in your research no longer being eligible for the exemption that has been granted.
Record Keeping You are responsible for maintaining a copy all research related records in a secure location in the event future verification is necessary, at a minimum these documents include: the research protocol, the claim of exemption application, all questionnaires, survey instruments, interview questions and/or data collection instruments associated with this research protocol, recruiting or advertising materials, any consent forms or information sheets given to subjects, or any other pertinent documents.
Final Report When you have completed work on your research protocol, you should submit a final report to the Office for Protection of Research Subjects (OPRS).
Information for Human Subjects UIC Policy requires investigators to provide information about the research protocol to subjects and to obtain their permission prior to their participating in the research. The information about the research protocol should be presented to subjects in writing or orally from a written script. When appropriate, the following information must be provided to all research subjects participating in exempt studies:
The researchers affiliation; UIC, JBVMAC or other institutions,
The purpose of the research,
The extent of the subject's involvement and an explanation of the procedures to be followed,
Whether the information being collected will be used for any purposes other than the proposed research,
A description of the procedures to protect the privacy of subjects and the confidentiality of the research information and data,
f. Description of any reasonable foreseeable risks,
Description of anticipated benefit,
A statement that participation is voluntary and subjects can refuse to participate or can stop at any time,
A statement that the researcher is available to answer any questions that the subject may have and which includes the name and phone number of the investigator(s).
A statement that the UIC IRB/OPRS or JBVMAC Patient Advocate Office is available if there are questions about subject's rights, which includes the appropriate phone numbers.

Please be sure to:

→ Use your research protocol number (2014-0668) on any documents or correspondence with the IRB concerning your research protocol.

We wish you the best as you conduct your research. If you have any questions or need further help, please contact the OPRS office at (312) 996-1711 or me at (312) 355-2908. Please send any correspondence about this protocol to OPRS at 203 AOB, M/C 672.

Sincerely,

Charles W. Hoehne, B.S., C.I.P.
Assistant Director
Office for the Protection of Research Subjects

cc: Paul Brandt-Rauf, Public Health, M/C 923
Michael Petros, Public Health, M/C 923

Jason Orcena,
Public Health
940 Londan Ave
Suite 1100
Marysville, OH 43040
Phone: (740) 361-4155 / Fax: (937) 645-3047

August 10, 2014

Charles W. Hoehne, Assistant Director
Office for the Protection of Research Subjects (OPRS)
Office of the Vice Chancellor for Research (MC 672)
203 Administrative Office Building
1737 West Polk Street
Chicago, Illinois 60612-7227

RE: Research Protocol # 2014-0668-83381-1
"For a Few Dollars More: The Case for Cross-Jurisdictional Sharing in Ohio's Local Health Departments"

Dear Asst. Director Hoehne:

Thank your for your recent communication regarding my IRB request for exemption reviewed on August 4, 2014. My responses are indicated below:

Application (Page 7 of 11, Item VIII.C):
The timeline has been eliminated.
The revised text is included. See attached.
The application indicates, "The nine district directors (health officers) will be contacted in person and asked to support data collection at their monthly meetings with health department's health officers." Given this:
A copy of the script for the Directors has been included. See attached.
See attached. The nine district directors (health officers) will be contacted in person and asked to share the request for survey participation at their next monthly meeting with local health department's health officers. The District Directors will share the purpose and background of the survey with their district members and direct any additional questions to the PI. Such a request is not unusual and is part of the customary practice of the association (to relay survey requests from academia to the members). It is not the intent of the PI to have the district directors encourage, or by extension coerce, participation. Nor is it likely to occur given the frequency of such requests. See attached.
Application (Page 7 of 11, Item VIII.D.2): **The following data sources are publicly available and/or considered a public record: Ohio Public Performance Database (for Local Health Departments-public record available from the Ohio Department of Heatlh); Annual Financial Report (public record available from the Ohio Department of Health); US Census (public record available from**

the US Census Bureau). The remaining data is a data-set available upon request from NACCHO. However, I will be using a modified NACCHO dataset housed by Ohio RAPHI (Research Association for Public Health Improvement). The use agreement has been submitted but a response has not been received as of the date of this notification—see attached use agreement.

Application (Page 8 of 11): **Each respondent and corresponding LHD will be assigned a codename. This will serve to de-identify both the respondent and their agency in the analysis. In addition, the survey participants are health officers (publicly appointed officials) responding about their agency's activities and relationships with other public agencies (LHDs) pursuant to the public programs they provide. Most of the information could be gleaned from detailed analysis of agency activities. The survey is simply the most expeditious way to collect the information. The respondent is not integral to the study (providing they are knowledgeable about the activities of the agency) since the unit of analysis is the health district. The use of REDCap or Qualtrics would nullify the network analysis tool central to the study, i.e. PARTNER.**

Regarding the Survey:
Job title has been removed from the survey question. LHD is a required field for the analysis, however, a codename will be assigned to each respondent and corresponding LHD at the time of response.
Even though the survey is relatively short (18 questions), the time it takes to complete is dependent on the number of partners identified in the survey process. For each partner (LHD) identified, all 18 questions must be completed regarding the relationship. The upward limit of the partners would be 125 (the number of LHDs in Ohio); the minimum would be zero (no partners).

Regarding the recruitment/consent Letter Email:
See attached.
See attached.
See attached.
See attached. Though a number has been included, in this instance, the participants are public appointed individuals representing a finite number of agencies. The number of participants would be known to respondents.
See attached.
See attached. The individuals to whom the survey is being sent are public officials commenting on their agency's involvement in activities that could be reasonably deduced from publicly available information. A codename for both the respondent and agency will be assigned before analysis.

If there are any further questions, please do not hesitate to contact me further at Jason.orcena@uchd.net or by phone (937) 642-2053.

Sincerley,

Jason E. Orcena

Enclosure(s): 3

cc: Michael Petros, Public Health, M/C 923

Appendix D. Key Terms and Diagrams for Understanding Network Analysis

KEY TERMS

Arc	Otherwise known as a link, edge, or step. Indicates a connection between two organizations.
Centrality (degree)	The count of the number of connections a network member has to other members of the network divided by the total possible number of connections. May be standardized by dividing by all possible connections Sum of all direct links between an actor and all other actors they are directly connected to.
Centrality (closeness)	Closeness is a measure of the degree to which a network member is near all other individuals in a network. It is the inverse of the sum of the shortest distances between each node and every other node in the network. Sum of the count of the distance (number of links) between an actor and all other actors.
Clique	In network analysis, a clique is a sub-set of a network in which the actors are more closely and intensely tied to one another than they are to other members of the network
Organizational (Social) Network Analysis	Organizational (Social) network analysis (ONA) is the analysis of social networks in terms of network theory, consisting of nodes (representing individual actors/ organizations within the network) and ties (which represent relationships between the individuals, such as resource sharing, information exchange, etc.).
PARTNER (Partner® .net)	A free, Robert Wood Johnson sponsored organizational (social) network analysis tool designed to measure and monitor collaboration among people/organizations.

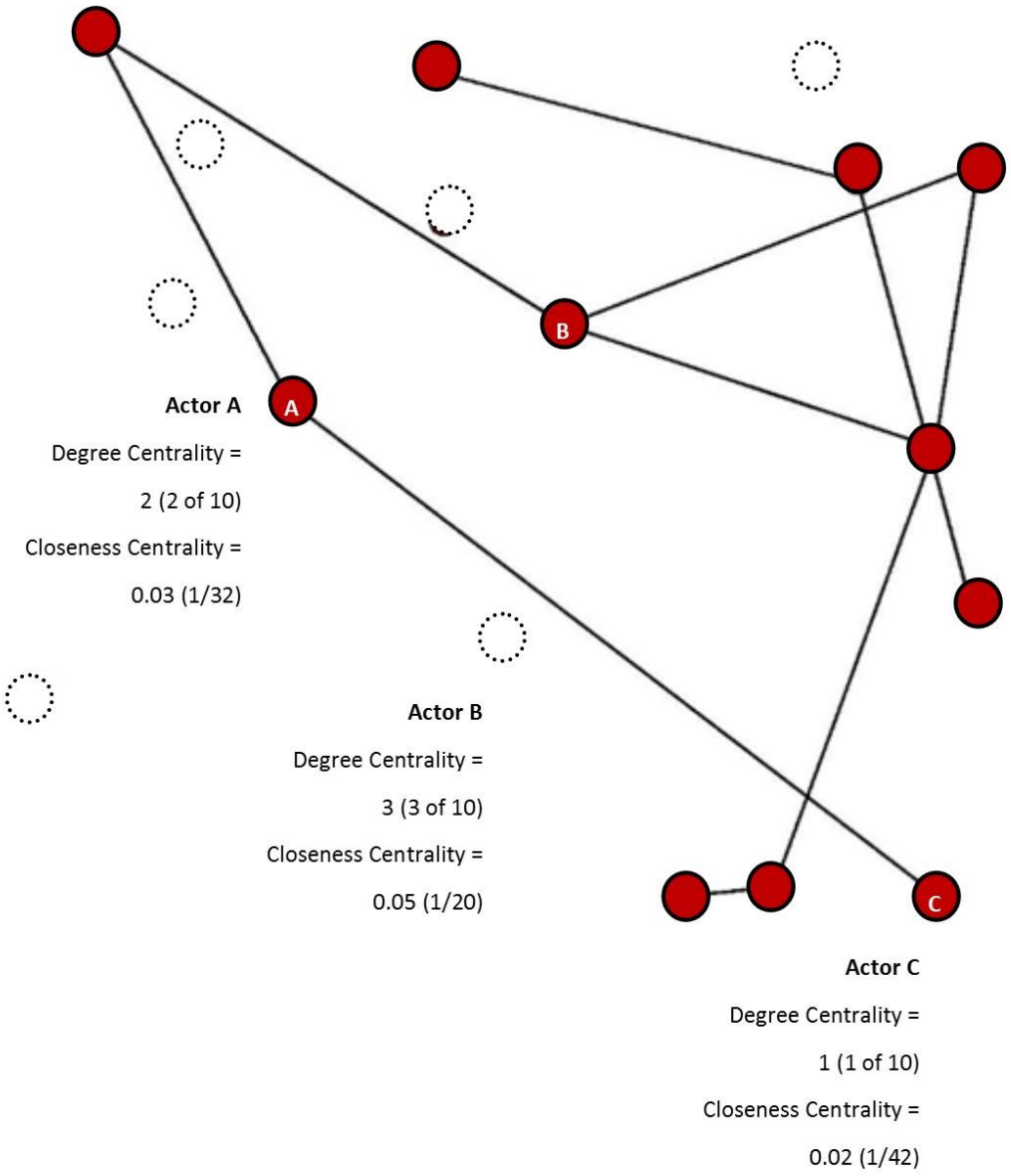
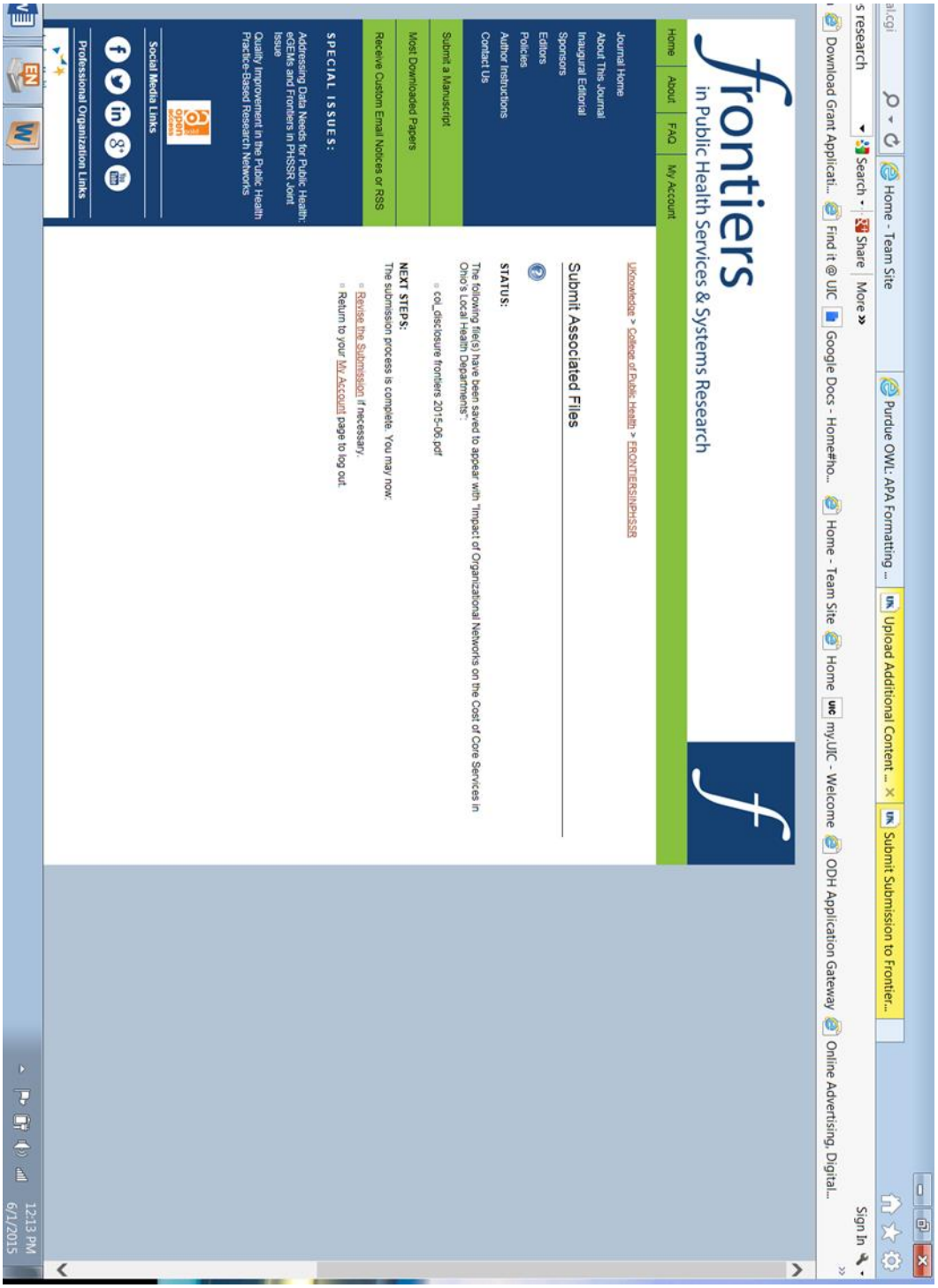
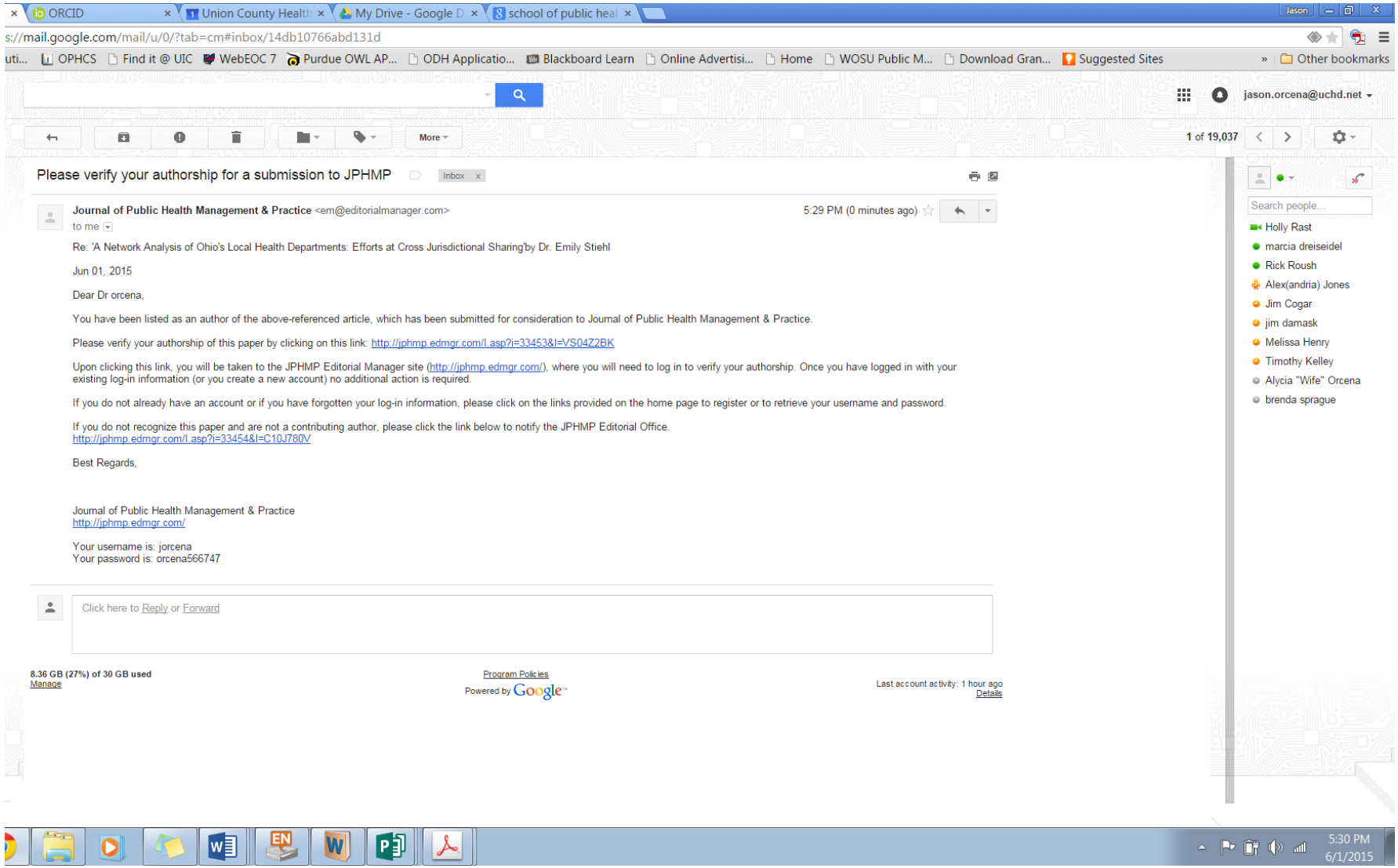


Figure 16. Example of Key Network Concepts

Appendix E. Article Submissions




ORCID
Union County Health
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s://mail.google.com/mail/u/0/?tab=cm#inbox/14db10766abd131d
OPHCS
Find it @ UIC
WebEOC 7
Purdue OWL AP...
ODH Applicatio...
Blackboard Learn
Online Advertisi...
Home
WOSU Public M...
Download Gran...
Suggested Sites
Other bookmarks
jason.orcena@uchd.net
More
1 of 19,037
Please verify your authorship for a submission to JPHMP
Inbox
Journal of Public Health Management & Practice <em@editorialmanager.com>
to me
5:29 PM (0 minutes ago)
Re: 'A Network Analysis of Ohio's Local Health Departments: Efforts at Cross Jurisdictional Sharing'by Dr. Emily Stiehl
Jun 01, 2015
Dear Dr orcena,
You have been listed as an author of the above-referenced article, which has been submitted for consideration to Journal of Public Health Management & Practice.
Please verify your authorship of this paper by clicking on this link: http://jphmp.edmgr.com/l.asp?i=33453&l=VS04Z2BK
Upon clicking this link, you will be taken to the JPHMP Editorial Manager site (http://jphmp.edmgr.com/), where you will need to log in to verify your authorship. Once you have logged in with your existing log-in information (or you create a new account) no additional action is required.
If you do not already have an account or if you have forgotten your log-in information, please click on the links provided on the home page to register or to retrieve your username and password.
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8.36 GB (27%) of 30 GB used
Manage
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Holly Rast
marcia dreiseidel
Rick Roush
Alex(andria) Jones
Jim Cogar
jim damask
Melissa Henry
Timothy Kelley
Alycia "Wife" Orcena
brenda sprague
5:30 PM
6/1/2015

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Wholey, D. R., Gregg, W., & Moscovice, I. (2009). Public health systems: A social networks perspective. Health Services Research, 44(5p2), 1842-1862. doi:10.1111/j.1475-6773.2009.01011.x

Yin, R. (2009). *Case study research, design and methods* (4th ed.) Newbury Park, CA: Sage Publications

VITA

Jason E. Orcena, M.A.

Professional Experience:

Union County Health Department, 2008-Present, (937) 642-2053
Health Commissioner

Union County Health Department, 2002-2008, (937) 642-2053
Division Director (Health Education & Community Partnerships)

Union County Health Department, 1998-2002, (937) 642-2053
Program Supervisor/Specialist (Health Education & Community Partnerships)

Marion Technical College, 1995-2002, (740) 389-4636
Community Faculty

The Ohio State University, 1996-1998
Teaching Associate/ Graduate Associate (Sociology Research Lab)

VOCA Corporation of Ohio, 1995-1996, (740) 389-1477
Director ICF-MRDD

Education & Professional Development

Education

Master of Arts, Sociology, The Ohio State University, 1999.
Thesis: "The Impact of Social Militarization on Literacy Rates in Developing Countries"

Bachelor of Arts with Distinction, Psychology, The Ohio State University, 1995.
Magna Cum Laude, Honors Thesis: "Maslow's Hierarchy of Needs: Gender Differences in Motivation"

Associate of Arts, The Ohio State University, 1995.

Honors: Phi Beta Kappa Award of Excellence; Social & Behavioral Sciences Award of Excellence

Professional Presentations

- "Making Sausage: The politics of developing a Core Package of Public Health Services in Ohio". Plenary Session, Open Forum for Quality Improvement in Public Health, National Network of Public Health Institutes, 2013.

- "Physical Activity and Nutrition in Afterschool Programs". National Afterschool Association Annual Conference, 2012.
- "LHD Funding & Levies". Leadership Essentials for Health Directors, 2011, 12, 13.
- "LHD Funding & Appropriations". Health Commissioner University, 2010, 11, 12, 13.
- "Spread the Message Not a Disease". NACCHO Annual Conference, 2008. (Poster Session)
- "Wellness Policies in the Afterschool Program: Getting Kids Moving", National After School Association Annual Conference, 2008.
- "Four Stage Typology for Organizational Change in Health Promotion". Public Health Combined Conference, 2006. (Poster Session.)
- "Stages of Change: A mechanism for Organizational Behavior Change in Public Health Partnerships". Worksite Wellness Conference, 2005. (Poster Session.)
- "Intro to & Advanced Desktop Publishing with MS Publisher", Ohio Association of Recycling & Litter Prevention Professionals, 2005.
- "HIPAA Compliance for Local Health Departments", Association of Ohio Health Commissioners, 2003.
- "Cooperative Activities for Middle School Programs", National Middle School Conference, 1999
- "Incorporating Safety Education into After School Programs", Ohio Department of Education Annual Conference, 1998
- "The Role of the IPP in Addressing Behavioral Concerns", Conference of Ohio Nursing Home/ Rehabilitation Staff, 1996

Courses Taught

- Introductory Sociology, Marion Technical College, 1996-2002
- Introductory Psychology, Marion Technical College, 1996-2002
- Statistics for Social Sciences, Ohio State University, 1998
- Research Methodology, Ohio State University, 1997
- Introductory Sociology, Ohio State University, 1996

Publications

- "Funding & Local Appropriations: Money, Where to Get and How to Spend It." Ohio State University Center for Public Health Preparedness Online Course, 2013.
- Association of Ohio Health Commissioners. (2012). Public Health *Futures*: Considerations for a New Framework for Local Public Health in Ohio.
- Prabu David, Aletheia Henry, Jatin Srivastava, Jason Orcena & Jennifer Thrush (2012): Reactance to a Tailored Multimedia Intervention Encouraging Teachers to Promote Cover-the-Cough, Journal of Health Communication: International Perspectives, DOI:10.1080/10810730.2011.650826
- Orcena, Jason E. (2011). An Analysis of a Local Public Health Coalition Using Partnertool.net. (manuscript)
- Owsiany, David J. & Orcena, Jason E. (2010, April 14). "Who Should Control Tobacco-Fund Money". The Columbus Dispatch. Retrieved from http://www.dispatch.com/content/stories/editorials/2010/04/14/who-should-control-tobacco-fund-money.html.

- Thrush, Jennifer; Orcena, Jason; & David, Prabu. (2007). Chicks Dig Guys Who Wash Their Hands: The Role of Novelty and Collaborative Message Development in a Hand Washing Campaign. (Unpublished manuscript)
- Huelskamp, Nicole; Henry, Alethia; Thrush, Jennifer; Orcena, Jason; & David, Prabu. Likelihood of Teachers to Discuss Cover-the-Cough Techniques with Students. Association for Education in Journalism and Mass Communication Annual Conference 2007. (Paper)
- Orcena, Jason; Fahey, Denise; & McGee, Megan. (2004). Games Club: Conflict Resolution through Interactive Play. Marysville, OH: Union County Health Department
- Orcena, Jason. (2002, 2005). Middle-School Student Harassment & Victimization Study. Marysville, OH: Union County Health Department, Conflict Resolution Program.
- Orcena, Jason. (2000). 1999 Injury Surveillance Report. Marysville, OH: Union County Health Department.
- Reviewer, Introduction to Public Health Online Course, Ohio State University, College of Public Health, Center for Public Health Practice, 2012-2013.
- Reviewer, Preceptor Guide, Ohio State University, School of Public Health
- Reviewer, American Journal of Public Health. 2003-2008
- Reviewer, Journal of Health Promotion Practice. 2003-Current

Coalitions and Committee Service

- Board of Directors, Health Policy Institute of Ohio, 2015-Current
- Board of Directors, Local Public Health Services Collaborative, LLC, 2013-Current
    - President, 2013-Current
- Board of Directors, Association of Ohio Health Commissioners, 2011-Current
- Board of Directors, Council for Union County Families, 2008-Current
    - Chair, 2011, 2012
- Board of Directors, Ohio Public Health Partnership, OPHA Representative 2012-Current (Alternative Representative, 2009-2012)
- Health Commissioner University, Co-Chair, AOHC 2010-Current
- Co-Principal Investigator, Robert Wood Johnson Delivery and Cost of Services [of Local Public Health] Research Grant, 2013-2014
- Board of Directors, Union Star Center for Health & Wellness, 2010-2013
- GOPHR Committee, 2010-2013 (Formerly "Million Dollar Ideas")
- Co-Chair, Public Health *Futures* Fiscal Analysis Committee, AOHC 2012
- Legislative *Futures* Review Committee, AOHC Alternative Representative 2012
- Steering Committee, Public Health *Futures*, AOHC 2012
- Union County Hoarding Taskforce, Chair, 2012
- Local Government Partnership (TPP), representing AOHC, 2010-current
- IMPACT, Ohio Department of Job & Family Services, Central Region Chair, 2010-2011
- Board of Trustees, Ohio Public Health Association, 2007-2011
    - President, 2009 (VP, 2008)
    - Chair, Ohio Public Health Association, Constitution & Bylaws Committee
- Board of Trustees, Union County Chamber of Commerce, 2002-2009
    - Secretary, Executive Committee, Union County Chamber of Commerce Board, 2003-2005

    - Member, Union County Chamber of Commerce, Bylaws Committee, 2004-08
- Executive Committee, Union County Safety Council, 1998-2008
    - President, Union County Safety Council, 2002
- Member, Partnership to Fight Chronic Disease. (2009)
- Chair, Union County Chamber of Commerce Wellness Consortium, 2006-2008
- Chair, Union County Community Assessment Committee, 2007-2008
- Central Ohio Regional Public Information Officers Committee, 2003-2008
- Central Ohio Public Information Network, 2007-2008
- Government and Public Administration Career Field Technical Content Standards Document, Academic Alignment Review Panel, 2006
- Member, National Association of City/County Health Officials, 2006-Current
    - Membership Committee, 2006-2010
- Union County Leadership Institute, 2006
- Ohio Public Health Leadership Institute, 2004-05
- Mid-Ohio Regional Planning (MORPC) Multi-County Strategic Planning (Participant), 2003
- Marysville Public Library Strategic Planning (Participant), 2003
- Executive Roundtable, Union County, 2003
- Member, Ohio Safe Kids, 1999-2003
- Founder/ Chairman, Union County Safe Communities/ Safe Kids, 1998-2002
- Co-Founder/ Chairman, Cardiovascular Health/ Healthy Workforce Initiative Workgroup, 2003-2006
- Friends of the Union County Health Department Levy Committee, 2000-2012

Policy & Advocacy

- Public Health Funding & Policy Changes, Biennial Budget, Testimony Representing AOHC, Ohio Senate (2013)
- Dangerous and Exotic Animal Laws, Testimony Representing AOHC, Ohio House (2012)
- "Preventing Recreational Water Illness in Ohio's Water Parks: The Impact of Ohio Revised Code". Policy Analysis. (2012)
- Funding Priorities for Local Public Health, Testimony Representing AOHC, Ohio House (2010)
- Opposition to Murkowski Amendment, Press Conference Representing OPHA (2010)
- "Impact of Climate Change on the Public's Health". Speech on the Statehouse Lawn, Earth Day. Representing OPHA (2010)
- Health Reform Priorities & Support. Press Conference for the Partnership to Fight Chronic Disease, Representing OPHA (2009)
- Tobacco Funding, Testimony Representing OPHA, Ohio Senate (2008)

Grants Awarded

- Local Government Innovation Fund. 2012. $56,000.
- Robert Wood Johnson, Quick Strike Grant. 2012. $25,000.
- Ohio Department of Health, Cardiovascular Health. 2005-2008. $228,000.
- Ohio Department of Health, Cardiovascular Health. 2002-2004. $41,000.

- Ohio Department of Health, Intentional Injury. 2005-2008. $140,000
- Ohio Department of Health, Intentional Injury. 2000-2004. $110,000
- Ohio Department of Public Safety. Safe Communities. 1997-2008. $405,500
- Ohio Tobacco Prevention Foundation. Community Grant II. 2003-2006. $346,000
- Ohio Tobacco Prevention Foundation. Community Grant III. 2008. $147,000
- STIPDA, Safe Routes to School, 2007-08, $15,000
- Columbus Medical Foundation, 2008. $2,000

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