NETWORK COLLABORATION AND ORGANIZATIONAL PRODUCTIVITY

WITHIN A REGIONAL COLLECTIVE IMPACT INITIATIVE

A Dissertation

by

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Submitted to the Office of Graduate and Professional Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

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May 2020

Major Subject: Health Education

ABSTRACT

Collective Impact (CI) emerged in recent years as a promising approach to address complex, community-level health and social issues. CI involves the commitment of multi-sector organizations to address a given issue using a structured approach. The CI framework includes five major elements: 1) common agenda, 2) shared measurement system, 3) mutually reinforcing activities, 4) continuous communication, and 5) backbone organization. Limited research exists on the application of the CI framework, including how the framework relates to CI collaboration and efforts towards community impact. To begin to address this gap, this study employs an two-timepoint interorganizational network (ION) analysis of an infant safe sleep CI initiative in the Hampton Roads Region of Virginia, SleepTight Hampton Roads (N=23). We also explore organizational productivity of the CI members by employing a quadratic assignment procedure (QAP) correlation. ION findings indicate that while the five CI framework elements exist in practice, variations may occur. In addition, we find that the roles of organizations in relation to centrality change over time, as well as how changes can occur in relation to overall connectedness of in-network and out-network actors, particularly in collaboration dimensions such as technical assistance, jointly planning activities, and sharing tangible resources. Finally, we uncover that, in this CI case, centrality is not correlated with organizational productivity towards the CI network's mission, although overall productivity may be strong. This research provides insight on CI in practice and allows for future research to continue to explore build empirical knowledge to understand CI theoretical framework application.

DEDICATION

Dedicated to Amma. Thank you for everything, always.

ACKNOWLEDGEMENTS

Thank you to my committee chair, Dr. Whitney Garney, for the support throughout this project and my graduate school career. I also wish to thank my committee members, Drs. Gerard Carrino, Laura Dague, and Kelly Wilson for your guidance during dissertation development, as well as the support of Dr. Bryce Hannibal. Finally, thank you to my community partners at Minus 9 to 5, including Jane Glasgow, Beth Parker, and Jessica Gipson for their integral support during project development and data collection.

Thank you also to the faculty, staff, and students at the Texas A&M Department of Health and Kinesiology, who provided support in innumerable ways throughout these past few years. Thank you to my lifelong friends and loved ones, both in Texas and away, for believing in me and cheering me on every day. Finally, thank you to my family. Without you, I would not be here. I owe everything to you and am so grateful for how you helped me grow. I love you all so much.

CONTRIBUTORS AND FUNDING SOURCES

Contributors

This work was supervised by a dissertation committee consisting of Professors Whitney Garney and Kelly Wilson of the Department of Health and Kinesiology, Professor Gerard Carrino of the School of Public Health, and Professor Laura Dague of the Bush School of Government and Public Service. Study design and implementation was supported by Bryce Hannibal, formerly of the Bush School of Government and Public Service, as well as Jane Glasgow, Beth Parker, and Jessica Gipson from the Eastern Virginia Medical School's Minus 9 to 5 program. All other work conducted for this dissertation was completed by the student independently.

Funding Sources

Graduate study was supported by Texas A&M University and the Jane and Collie Conoley doctoral fellowship from the Texas A&M College of Education and Human Development.

TABLE OF CONTENTS

Page

LIST OF FIGURES

Page

LIST OF TABLES

Page

1. INTRODUCTION

The systems-focused approach is emerging as a way to address complexity in health disparities. This approach allows public health professionals to view health problems through a wide lens, thinking through multiple factors that influence health conditions outside of individual behavior choices (Christens & Inzeo, 2015; Peters, 2014). Systems approaches consider the various levels of the social ecology that may positively or negatively affect the issue (Meadows, 2008; Singer, 2009). Levels of the social ecology include individual, interpersonal, organizational, community, and policy level factors connected to the health issue (McLeroy, Bibeai, & Steckler, 1988). Given this wide lens angle, systems approaches are particularly useful when addressing health disparities, due to the range of socioecological complexities that influence and aggravate issues in disparate populations (Bagnall, Radley, Jones, Gately, Nobles, Van Dijk, & Sahota, 2019).

Negative health conditions that persist within disparate populations historically have been attributed to behavior choices (Noar & Zimmerman, 2006). However, evidence indicates these health issues are often influenced more by socioecological factors, such as access to healthcare and inequalities in education, than by individual choice (DeSalvo, O'Carroll, Koo, Auerbach & Monroe; 2016; McLeroy, Kegler, Steckler, Burdine & Wisotzky, 1994). Additionally, interventions that implement a single-issue focus in the realm of health disparities fall short of progress towards positive impact compared to interventions implemented by multiple agencies as they are unable

to address multi-level factors related to the issue (Bagnall et. al., 2019). Oftentimes, multi-level interventions involve collaboration among agencies from a range of sectors including partners from the academic field, government, non-governmental organizations, and other fields due to their diverse nature and need for a wide range of resources (Armstrong, Doyle, Lamb & Waters, 2006).

The public health profession has increased emphasis on cross-sector collaboration in programs and interventions in order to "engage with community stakeholders — from both the public and private sectors — to form vibrant, structured, cross-sector partnerships," (DeSalvo, Wang, Harris, Auerbach, Koo, O'Carroll, 2017, p. 4). This emphasis on collaboration addresses health disparities by allowing stakeholders to work together and to use their various perspectives to create systems solutions to complex public health issues (Wolff, Minkler, Wolfe, Berkowitz, Bowen, Dunn Butterfoss, Christens, Francisco, Himmelman & Lee, 2017).

The public health workforce has employed cross-sectoral partnerships for many years to foster collective action to address community-level health issues, particularly those that drive health disparities (DeSalvo et. al., 2017). These collaborations are often called community coalitions, which have been used for decades to address various health concerns of a given community (Goodman, Wandersman, Chinman, Imm & Morrissey, 1996; McLeroy et. al., 1994). The use of a collaborative action through community coalitions has helped alleviate health disparities that emerge from existing social and economic differences (Giachello, Arrom, Davis, Sayad, Ramirez & Nandi, 2003; Wolff et. al., 2017). While community coalitions have demonstrated effectiveness in the health

field, evidence suggests that a lack of centralized management in coalitions may present limitations to overall coordination, which potentially limits impact over time (Valente, Chou & Pentz, 2007).

1.1. Collective Impact

Collective Impact was developed to address this structural limitation by providing a framework for a centralized coalition strategy (Kania & Kramer, 2011). Collective impact (CI) is a systematic framework that describes how a structured, cross-sector approach can be used to address complex problems from the perspectives of multiple organizations from a variety of sectors (Kania & Kramer, 2011). This framework uses a centralized approach, which helps offset recurrent issues, such as lack of participation and commitment by members (Valente, et. al., 2007). Rather than these organizations working in silos on similar community intentions, they collaborate towards an achievable mission becomes the focus for all organizational members (Hanleybrown, Kania & Kramer; 2012; Kania & Kramer, 2011).

Collective Impact is classified using a set of five distinct "conditions." These conditions include: a common agenda, shared measurement systems, mutually reinforcing activities, continuous communication, and backbone support organization(s) (Kania & Kramer, 2011; Kania & Kramer, 2013). Within CI, a common agenda refers to all members of a given CI approach sharing a vision and common understanding of the problem and a joint approach to solve the problem. Shared measurement refers to consistent data collection across members to ensure efforts remain aligned and everyone is held accountable. Mutually reinforcing activities involves the differentiation yet

coordination of activities through a mutually reinforcing plan of action. This refers to activities that cohesively work towards the common agenda. Relatedly, continuous communication involves consistent, open member communication, conducted in a way to build trust, mutual objectives, and common motivation. Finally, CI has at least one organizational member who serves as a backbone support organization, which provides staff focused on the coordination of participating organizations (Kania & Kramer, 2011). In the field of health education and promotion, CI has gained popularity, causing many communities to begin to explore the benefits of using this approach in health promotion practice (Flood, Minkler, Lavery, Estrada & Falbe, 2015). CI models in practice have implemented interventions focused on obesity prevention, substance use, teenage pregnancy and other topics (Flood et. al., 2015).

However, some coalitions or partnerships implement the practices of CI without the formal designation. For example, one study in Canada uses the term collective impact to describe a collaborator network focused on a multi-sector approach to address childhood obesity (Amed, Naylor, Pinkney, Shea, Mâsse, Berg & Higgins, 2015). While this community intervention employed many aspects of CI, and is described as such, the intervention practices did not fall into all domains of the CI framework. This practice is significant because it underscores the importance of considering whether all elements of the CI framework are utilized. When these applications occur, it becomes difficult to discern whether to the CI framework, or a traditional community collaboration, is the modality delivering change to the community. Ensuring if CI's fulfill or aim to fulfill CI frameworks help advance the research and better understand its direct application in the

field (Flood et. al., 2015). In order to test effectiveness of CI, as is the case with empirical tests of theoretical frameworks, it is important to maintain fidelity to the CI framework to more reliably examine CI application.

The field has developed an increased interest in other topics related to CI in practices, including the application of CI to children's health disparities, CI membership collaboration, and members' productivity towards a CI common agenda. CI has been discussed as an approach that, as designed, could address cultural exclusion, particularly in health issues facing youth and children. However, research has yet to indicate how the CI framework works in these types of interventions, such as health disparities in low income children or racial/ethnic minorities (LeChasseur, 2016).

Researchers are also interested in the collaboration patterns among participating CI agencies (Walzer, Weaver & McGuire, 2016). Research indicates that effective CI collaboration is determined, in part, by a focus on relationships (Gillam, Counts, & Garstka, 2016) and elements of interorganizational structures conducive to community change (Christens & Inzeo, 2015). By examining characteristics of these interorganizational relationships in CI, we are better able to understand how different sectors work together and how aspects of these relationships may evolve over time (Wendel, Prochaska, Clark, Sackett & Perkins, 2010). Research also indicates that a major contributor to CI success is its representativeness of the stakeholders involved (Kania & Kramer, 2013). However, it is unclear whether a certain type or aspect of the organizational members serves as better indicators of productive members towards the common agenda.

This study aims to understand how organizational characteristics and collaboration contribute to success or productivity in CI. This study aim will be examined using a specific application to a CI initiative called the Sleeptight Hampton Roads Advisory Committee (SHRAC). SHRAC is a meaningful initiative to study given that it is designed to address youth health issues. Additionally, given the newness of CI in the field, it is an opportunity to study a CI initiative that is established, but also newly engaging in collaboration. SHRAC is made up of group of multi-sector organizations, including representatives from local government, healthcare, nonprofit organizations, and community organizations, that work together towards a common agenda, using a backbone agency. The present study examines whether SHRAC implements other elements of the CI as well as these two aforementioned elements.

1.2. Minus 9 to 5's Sleeptight Hampton Roads Advisory Committee

The Eastern Virginia Medical School's Minus 9 to 5 program emerged in 2015 to address a lack of community programs and services that help low-income families with young children in the Hampton Roads region of Virginia. A significant number of newborn babies in the Hampton Roads region face significant health issues including low-birth weight, premature mortality, and other issues (Minus 9 to 5, n.d.-a). In order to strategically address these issues, Minus 9 to 5 convened multiple working groups that focused on specific prenatal and postpartum health missions. The working group of focus in this study (i.e., study population) is Minus 9 to 5's Sleeptight Hampton Roads Advisory Committee (SHRAC). SHRAC is one of many CI initiatives that Minus 9 to 5 employs to improve children's health in the area.

SHRAC was initially implemented as an initiative, Sleeptight, in 2008 in response to two infant rollover deaths reported in the area (Sleeptight Hampton Roads, n.d.). For multiple years, one organization, the Children's Health Investment Program of South Hampton Roads, independently provided Hampton Roads families with portable cribs and safe sleep education to reduce infant mortality, but cited programmatic limitations including lack of resources and mixed messages to the public (Sleeptight Hampton Roads, n.d.). As a result, in 2016, under Minus 9 to 5's direction, a group of more than twenty organizations convened to support this mission by aligning priorities and branding consistent education on infant safe sleep. This working group was called the Sleeptight Hampton Roads Advisory Committee (SHRAC) (Minus 9 to 5, n.d.-b; Sleeptight Hampton Roads, n.d.).

The ultimate goals of the SHRAC are to educate the target population on infant safe sleep and to provide resources (e.g., cribs) to families that can aid in reducing unsafe infant sleep habits. The mission of the SHRAC CI became to "create a culture of infant safe sleep in the Hampton Roads region through collaboration, partnership, and collective action" (Sleeptight Hampton Roads, n.d.). Current organizational members include those from local government, healthcare, nonprofits, and community organizations. Through their collaboration, the SHRAC transformed from a one organization initiative to a multi-organization CI initiative working towards achieving conditions of the CI framework, including a common agenda, shared measurement systems, mutually reinforcing activities, and continuous communication.

The SHRAC includes one organizational member that serves as the CI backbone support organization, as outlined in the CI framework. This organization is the Eastern Virginia Medical School (EVMS) Department of Pediatrics, led by staff who focus on Minus 9 to 5 working group efforts. Due to this integral role, Minus 9 to 5 staff in the EVMS Department of Pediatrics served as integral community partners in this research study.

1.3. Interorganizational Network Study

At its core, the focus of CI centers on the relationships between its members. Within the CI framework, shared measurement allows for a focus on tracking longitudinal indicators of success. However, measurement systems alone are not designed to capture multi-dimensional, changing CI dynamics that occur within interorganizational relationships (Kania & Kramer, 2013). As a result, the field recommends employing a developmental evaluation to complement the shared measurement systems to provide context and understand how and the why something occurs (Kania & Kramer, 2013; Patton, 2010).

This research project uses a developmental evaluation approach to study interorganizational networks in the SHRAC. Network analysis has been used in the health field to document personal social networks, service coordination, and interorganizational collaboration (Kegler, Rigler & Ravani, 2010). Interorganizational network (ION) analysis, specifically, allows researchers to study patterns of relationships between organizations in a given network, such as a CI network, to identify organizational positions in the network, trace central agents, find groupings, and

describe properties of the network as a whole (Valente, Coronges, Stevens & Cousineau, 2008). Network studies that collect information using a survey methodology allow researchers to gather data on the whole network by asking each network actor, in this case an organization, about their relationships with other actors in the network (Marsden, 2011).

1.3.1. Network Survey

The first portion of this study involves a survey-based interorganizational network (ION) analysis. ION is a useful tool to study how organizations work together to provide services and deliver interventions by examining different dimensions of collaboration (Maya-Jariego & Holgado, 2015). This survey was adapted from one previously developed by Garney et al., designed to examine interorganizational relationships in a collaboration of 15 community-based chronic disease prevention partnership networks (Garney, Patterson, Garcia, Muraleetharan & McLeroy, 2019). Garney et al.'s survey was designed and adapted from past network studies in the field (Goodman et al., 1998; Singer & Kegler, 2004; Kegler, Rigler, & Ravani, 2010; Wendel, Prochaska, Clark, Sackett, & Perkins, 2010; Clark et al., 2014) but was used as the main reference tool due to its recent administration and ease in adaptability to this study. Similar to Garney's survey, the ION survey for this study captures demographic information about the collaboration, as well as specific collaborative activities theoretically linked to interorganizational relationships. However, the survey in this study expands the content to capture an added dimension of collaboration specific to CI, specifically technical assistance.

The survey collects demographic and contextual information relevant to the CI including 1) the organization's sector, 2) how often the organization worked directly with the community, and 3) how closely the organization's mission/vision/values matched Minus 9 to 5's vision. These first two questions provide background on the members of the network and the impact the organizations have in the community of interest. The third question helps evaluators examine the common agenda CI condition (Kania & Kramer, 2011).

The majority of the survey focuses on dimensions related to collaboration to capture ION characteristics. The dimensions examined included information sharing; jointly planning, coordinating, or conducting activities, trainings, or events; sharing tangible resources; and sharing a formal memorandum of agreement (MOA) (Singer & Kegler, 2004; Davis, Koroloff & Johnsen, 2012; Kegler et. al., 2012; Clark, Ramirez, Drake, Beaudoin, Garney, Wendel & Player, 2014) The literature describes these dimensions as ways to measure collaboration based on stage and intensity (Singer & Kegler, 2004). That is, the act of sharing information between network members demonstrates the most basic type of collaboration, and having a formal working relationship documented through a contract or memorandum of understanding demonstrates a more developed stage of collaboration (Clark et. al., 2014; Singer & Kegler, 2004). These collaboration dimensions are based on the community health literature (Singer & Kegler, 2004; Clark et. al., 2014).

This study also adds an additional dimension of knowledge transfer through technical assistance, as training and technical assistance can often be major aspects of

collaborative community health initiatives (Davis et. al., 2012; Valente et. al., 2007). Technical assistance has often been examined as a significant element of health networks from the perspective of program development and implementation support (Shortell & Casalino, 2010; Silva, Sena, Seixas, Feuerwerker & Merhy, 2010). Given these aspects, the dimension of knowledge transfer through technical assistance was added to the initial four dimensions to capture any evidence of a deeper form of information sharing through technical assistance following the sharing information dimension.

These five collaboration questions were framed as a frequency measure for the first three dimensions of sharing information, knowledge transfer through technical assistance, and jointly planning events. Specifically, SHRAC survey respondents were asked, "How often in the last 12 months did your organization exchange or share information/give or receive technical assistance/jointly plan, coordinate or implement an activity, training, event, or program with the following organizations regarding infant safe sleep for Hampton Roads residents?" Answer options included "Once or twice," "Every few months," "Monthly/almost monthly," "Weekly/almost weekly," "Daily/almost daily," "Never," and "This is my organization." The other two collaboration questions were framed as Yes/No questions. Specifically, SHRAC survey respondents were asked, "In the last 12 months, did your organization share or exchange tangible resources with the following organizations regarding infant safe sleep for Hampton Roads residents?" and "Did your organization have a formal memorandum of agreement or contract with the following organizations regarding the shared resource?"

Answer options were “Yes,” “No,” and “This is my organization.” Appendices A includes the ION survey instruments used in the 2019 timepoint of data collection.

1.3.2. Network Measures

1.3.2.1. Density

Density indicates the extent of communication and cooperation between organizations in a network as a proportion of all probable ties in the network (Ergün & Usluel, 2016). Density is calculated as:,

$$D = \frac{l}{n * (n - 1)}$$

In this equation, l refers to the number of links in a network and n refers to the number of organizations in SHRAC (Valente, Chou & Pentz, 2007). More simply stated, density will measure the proportion of existing ties to the number of all possible ties that can exist in a given network.

1.3.2.2. Centrality

In network analysis, there are many types of centrality calculations, which provide variations on positional data for actors in a given network. The most frequently used centrality measures include degree, closeness, betweenness, and eigenvector (Valente, Coronges, Stevens & Cousineau, 2008). Closeness centrality refers to the length of the connections from one network actor to all other actors in the network, representing network actors on the periphery of a given network (Valente et. al., 2008). Betweenness refers to the identification of shortest paths in a network and the number of them that pass through an actor (Opsahl, Agneessens & Skvoretz, 2010). In other words, betweenness centrality helps describe actors who occupy a link in the shortest path of

other actors, as well as any redundant links among actors (Wang, Chiang, & Lin, 2009). Eigenvector centrality is seen as the weighted sum of direct and indirect connections of every link from a given network actor, representing actors connected to well-connected network members (Bonacich, 2007). Finally, Freeman's degree centrality refers to the number of nodes a given network actor is connected to (Opsahl et. al., 2010).

For the purposes of this study, degree centrality is explored. Degree centrality scores provide organization-specific data on who has the most linkages to other organizations, indicating which organizations may access more information or can connect to others more quickly. This information is important for the study since the SHRAC CI initiative is fairly new, and it is useful to know who are central figures in the network who can drive collaboration at this early stage. Identifying these partners is a critical first step when studying networks (Freeman, 2004; Opsahl et. al., 2010). Degree centrality will be calculated as follows:

$$k_i = \sum_{j}^{n} x_{ij}$$

In this equation, i refers to a single organization and j refers to all other organizations. x_{ij} is defined as 1 if node i is connected to node j, and 0 otherwise. Additionally, n once again refers to the number of organizations in SHRAC (Opsahl et. al., 2010). The calculation of degree centrality quantifies and provides position data for the organizations in the network (Ergün & Usluel, 2016). Organizations with high centrality scores are well connected to other organizations and can be considered central actors in the collaboration.

1.3.3. Predictive Analytics and Productivity

In the field of public health, particularly within partnerships focused on vulnerable populations, productivity is often studied relationally to how much value a program implementer delivers from an employee production standpoint (Chang & Liu, 2008; Meessen, Kashala & Musango, 2007). The proposed study goes beyond the individualistic framing of employee production to explore how organizational productivity is related to an interorganizational network mission and role in the network as a dependent variable. From the aspect of organizational productivity, this study will focus on common goals (Pritchard, Jones, Roth, Stuebing &Ekeberg, 1988). Research indicates that organizational productivity can be better accomplished by alignment with predetermined goals, or mission, set for the organization (Green, 2016; Pritchard et. al., 1988).

This study will measure SHRAC organizational productivity based on overall network goals in the ION survey. Productivity questions will be framed around the overall goal of the SHRAC, which is to provide information and resources on infant safe sleep to vulnerable families Hampton Roads (SleepTight Hampton Roads, n.d.). Specifically, the questions will examine if the individual members of the network have 1) provided information on safe sleep education to the Hampton Roads community over the past 12 months and 2) provided or donated resources to programs related to safe infant sleep over the past 12 months. I use predictive analytics to determine how various networks measures may be associated with productivity, and draw comparisons between individual organizations.

Predictive analytics in the field of network science involves applying a predictive (i.e., probability) score to an individual network actor to determine if there is an association with a given network measure and desired outcome (Abbott, 2014). Predictive analytic techniques range from statistical analysis to predictive modeling. While predictive analytics is often used in fields such as economics, its application in public health is underutilized (Bates, Saria, Ohno-Machado, Shah & Escobar, 2014). The final portion of this study will build a basis to develop a descriptive model that can provide a structured understanding for what makes for more productive collaborators in CI initiatives, and ultimately lead to a more effective initiative (Delen & Demirkan, 2013).

2. INTERORGANIZATIONAL NETWORK ANALYSIS OF A COLLECTIVE IMPACT INITIATIVE

2.1. Introduction

Frequently within public health and social services, multi-sector collaborations are used to support work and solve complex, community-level challenges. These collaborations often come in the form of community coalitions, which have been used for decades to address various health concerns of a given community (Goodman, Wandersman, Chinman, Imm & Morrissey, 1996; McLeroy, Kegler, Steckler, Burdine & Wisotzky, 1994). The term "community coalition" refers to a group of community partners and/or organizations who work together to achieve a common goal (Butterfoss & Kegler, 2009; Granner & Sharpe, 2004). In the field of community health, the use of a collaborative action through community coalitions helps to alleviate health disparities that emerge from existing social and economic differences (Giachello, Arrom, Davis, Sayad, Ramirez & Nandi, 2003; Wolff, Minkler, Wolfe, Berkowitz, Bowen, Dunn Butterfoss, Christens, Francisco, Himmelman & Lee, 2017). While coalitions have demonstrated effectiveness in the community health space, evidence suggests that a lack of centralized management and structure in coalitions may present limitations to overall effectiveness (Valente, Chou & Pentz, 2007).

The Collective Impact (CI) approach helps address this limitation by proposing a centralized coalition strategy guided by a structured framework (Kania & Kramer, 2011). However, there is limited literature evaluating how CI approaches operate in communities, particularly in the realm of collaboration between cross-sector

organizational members. The purpose of this study is to examine interorganizational collaboration within a CI initiative in Hampton Roads, Virginia, to provide insight on how CI partnerships operate. This study addresses a knowledge gap on how CI structure and collaboration operate in practice.

2.2. Minus 9 to 5's Sleeptight Hampton Roads Advisory Committee

The Eastern Virginia Medical School's Minus 9 to 5 program emerged in 2015 to address a lack of community programs and services that help low-income families with young children in the Hampton Roads region of Virginia. A significant number of newborn babies in the Hampton Roads region face significant health issues including low-birth weight, premature mortality, and other issues (Minus 9 to 5, n.d.-a). In order to strategically address these issues, Minus 9 to 5 convened multiple working groups that focused on specific prenatal and postpartum health missions. The working group of focus in this study (i.e., study population) is Minus 9 to 5's Sleeptight Hampton Roads Advisory Committee (SHRAC). SHRAC is one of many CI initiatives that Minus 9 to 5 employs to improve children's health in the area.

SHRAC was initially implemented as an initiative, Sleeptight, in 2008 in response to two infant rollover deaths reported in the area (Sleeptight Hampton Roads, n.d.). For multiple years, one organization, the Children's Health Investment Program of South Hampton Roads, independently provided Hampton Roads families with portable cribs and safe sleep education to reduce infant mortality, but cited programmatic limitations including lack of resources and mixed messages to the public (Sleeptight Hampton Roads, n.d.). As a result, in 2016, under Minus 9 to 5's direction, a group of

more than twenty organizations convened to support this mission by aligning priorities and branding consistent education on infant safe sleep. This working group was called the Sleeptight Hampton Roads Advisory Committee (SHRAC) (Minus 9 to 5, n.d.-b; Sleeptight Hampton Roads, n.d.).

The ultimate goals of the SHRAC are to educate the target population on infant safe sleep and to provide resources (e.g., cribs) to families that can aid in reducing unsafe infant sleep habits. The mission of the SHRAC CI became to "create a culture of infant safe sleep in the Hampton Roads region through collaboration, partnership, and collective action" (Sleeptight Hampton Roads, n.d.). Current organizational members include those from local government, healthcare, nonprofits, and community organizations. Through their collaboration, the SHRAC transformed from a one organization initiative to a multi-organization CI initiative working towards achieving conditions of the CI framework, including a common agenda, shared measurement systems, mutually reinforcing activities, and continuous communication.

In this way, SHRAC evolved from a one organization initiative to a multi-organization CI initiative working towards a common agenda, shared measurement systems, mutually reinforcing activities, and continuous communication. The backbone support organization for SHRAC is the local medical school that created Minus 9 to 5. Due to their role, Minus 9 to 5 staff in medical school operated as an integral partner in study implementation. This paper examines and analyzes relationships among organizational partners in Minus 9 to 5's SHRAC using a survey-based

interorganizational network analysis. The purpose of this study was to examine a CI in practice from the perspective of collaboration.

2.3. Methodology

To examine CI collaboration, an interorganizational network study was designed. Network analysis has been used in the community health field to document personal social networks, service coordination, and interorganizational collaboration (Kegler, Rigler & Ravani, 2010). Interorganizational network (ION) analysis, specifically, allows researchers to study patterns of relationships between and among organizations in a given network, such as a CI network, to identify organizational positions in the network, trace central agents, find groupings, and describe properties of the network as a whole, among other things (Valente, Coronges, Stevens & Cousineau, 2008). Network studies that collect information using a survey methodology can allow researchers to analyze the whole network by asking each network actor, in this case the individual organizations, about their relationships with other actors in the network (Marsden, 2011). The following section describes the ION survey used for this study and what types of relationship questions were answered by organizational actors.

2.3.1. Data Collection

Participants were identified and recruited by Minus 9 to 5 staff from a roster of current SHRAC members. Therefore, the ION had natural boundaries through organizational membership in the SHRAC. At the time of data collection, the committee included 23 organizations. One representative from each organization who participated in the SHRAC was recruited to complete the survey on behalf of the whole organization.

The study's ION survey was administered using the online survey software, Qualtrics©. It was distributed to organizational representatives (N=23) within SHRAC in Spring 2019 after approval by the Texas A&M University Institutional Review Board in June 2018 (IRB2018-0522).

The survey was designed to capture attribute and contextual information on SHRAC organizational members including 1) the organization's industry sector, 2) how often the organization worked directly with the Hampton Roads community, and 3) how closely the organization's mission/vision/values matched Minus 9 to 5's vision. Industry sector provides descriptive information about the network as a whole, allowing for examination on the representativeness of a multi-sector network across various industries (Rethemeyer & Hatmaker, 2008). Additionally, the literature indicates that frequency of working directly with the community and commitment to leadership (i.e., through organizational mission alignment) is associated with the flow and quality of collaboration and with overall positive network impact (Granovetter, 2005; Hayday, 2003). Relatedly, organizational mission alignment allows for an examination of the "common agenda" CI framework element (Kania & Kramer, 2011). Thus, examining these three factors provides context on the representativeness and quality of the network related to collaboration, impact, and a common agenda.

The remainder of the survey focused on dimensions of collaboration. The dimensions included information sharing, knowledge transfer through technical assistance; jointly planning, coordinating, or conducting activities, trainings, or events; sharing tangible resources; and sharing a formal memorandum of agreement or contract

(MOA) (Singer & Kegler, 2004; Kegler et. al., 2012; Davis, Koroloff & Johnsen, 2012; Clark, Ramirez, Drake, Beaudoin, Garney, Wendel & Player, 2014). The literature describes these dimensions as ways to measure collaboration based on stage and intensity (Singer & Kegler, 2004). That is, the act of sharing information between network members demonstrates the most basic type of collaboration, and having a formal working relationship documented through a contract or MOA demonstrates a more developed stage of collaboration (Clark et. al., 2014; Singer & Kegler, 2004). These collaboration dimensions, including sharing information, jointly planning, sharing tangible resources and sharing a formal MOA, are based on the community health literature (Clark et. al., 2014; Singer & Kegler, 2004). This study also included the added second dimension of knowledge transfer through technical assistance, as training and technical assistance can often be a major aspect of collaborative community health initiatives (Davis et. al., 2012; Valente et. al., 2007). These five dimensions align with the CI framework's dimensions of mutually reinforcing activities, as the collaboration domains examine collaboration towards activities designed to achieve intended impact of SHRAC.

Three of these five questions were framed as a frequency measure for the first three domains of sharing information, knowledge transfer through technical assistance, and jointly planning events. Frequency measures are important to capture as this aligns with the CI framework dimension of continuous communication. The domains of sharing resources and MOA/contract were binary (yes/no) measures. Table 1 provides details on all ION questions.

Table 2-1: ION Survey Questions

ION Question	Response Options
How often in the last 12 months did your organization *exchange or share information* with the following organizations regarding infant safe sleep for Hampton Roads residents?	1= Once or twice 2= Every few months 3= Monthly/almost monthly 4= Weekly/almost weekly 5= Daily/almost daily 0= Never
How often in the last 12 months did your organization *give or receive technical assistance* with the following organizations regarding infant safe sleep for Hampton Roads residents?	1= Once or twice 2= Every few months 3= Monthly/almost monthly 4= Weekly/almost weekly 5= Daily/almost daily 0= Never
How often in the last 12 months did your organization *jointly plan, coordinate or implement an activity, training, event, or program* with the following organizations regarding infant safe sleep for Hampton Roads residents?	1= Once or twice 2= Every few months 3= Monthly/almost monthly 4= Weekly/almost weekly 5= Daily/almost daily 0= Never
In the last 12 months, did your organization *share or exchange tangible resources* with the following organizations regarding infant safe sleep for Hampton Roads residents?	1= Yes 0= No
Does your organization have a *formal memorandum of agreement or contract* with the following organizations?	1= Yes 0= No

2.3.2. Data Analysis

From the 23-organization network, responses were collected from a majority of SHRAC members (n=13, 57%), exported from Qualtrics, and assigned numeric values. Reciprocity and mutualism to all five ION measures was assumed. This means that there was no directionality of relationships in any of the collaboration dimensions (Clark et. al., 2014; Schoen, Moreland-Russell, Prewitt & Carothers, 2014). The reciprocity procedure was necessary for this analysis to account for missing data from the organizational members that did not respond to the survey (Huisman, 2009).

Network data was then entered into a relational matrix with the frequency-ranked collaboration recoded for the information sharing, knowledge exchange through technical assistance, and jointly planning dimensions. In other words, frequency of interactions (i.e., Once or twice, Every few months, Monthly/almost monthly, Weekly/almost weekly, Daily/almost daily) would receive a numerical rank that ranged from 1 to 5. Frequency of interactions for the non-frequency dimension, answers received a rank of 1 or 0 as these were binary "yes" or "no" questions. Frequency of interactions was utilized to demonstrate relative strength of tie in the network diagrams, but these weights were not included in the analysis of density and degree centrality, due to the nature on how these measures are calculated, reported below. UCINET© network analysis software was used to analyze all network data with Netdraw used to create network graphs to visualize relationships. Two types of ION statistics were calculated on the network data and included density and degree centrality.

2.3.2.1. Density

Density examines the extent of connectivity between organizations in a network as a proportion of all probable ties in the network (Ergün & Usluel, 2016). This measure was calculated overall for the whole network, rather than individual network actors. Density was calculated for all five collaboration domain survey questions, treating each as an independent network, so that connectivity in each collaborative activity was examined individually. Density is calculated as such,

$$D = \frac{l}{n * (n - 1)}$$

where, *l* refers to the number of links in a network and *n* refers to the number of organizations in SHRAC (Valente, Chou & Pentz, 2007). More simply put, density will be calculated as the proportion of existing ties to the number of all possible ties that can exist in a given network.

To calculate, the rank values in the collaboration matrices were replaced with a 1, indicating some sort of link between the organizations. Where there was no type of relationship, the score was a 0, indicating no relationship. The value calculated would provide overall density of the network, with a network density value of 1 indicating that each organization is connected to all other organizations in some capacity.

2.3.2.2. Degree Centrality

In network analysis, there are many types of centrality calculations, which provide variations on positional data for actors in a given network. The most frequently used centrality measures include degree, closeness, betweenness, and eigenvector (Valente, Coronges, Stevens & Cousineau, 2008). For the purposes of this study, we focus on the degree centrality measure. Here, degree centrality scores provide organizational specific data on who is linked to other organizations, indicating which organizations may hold be able to access information or connect to others quickly. Effectively degree centrality is measuring a level of connectedness among organizations as a sum of ties to other organizations.

Centrality measures, including degree centrality, generally assume a network that is both undirected and dichotomous, or unweighted (Bell, Atkinson & Carlson, 1999; Wasserman & Faust, 1994). Degree centrality can also be calculated as in-degree or out-

degree in directed networks. For directed networks, in-degree centrality includes the number of connections that point inward at a network actor and out-degree centrality includes the number of connections that originate from a network actor and point outward (Hansen, Shneiderman & Smith, 2011). Given that reciprocity was applied to the data, degree centrality is calculated from the traditional, non-directional perspective. The theoretical underpinnings of this allow us to examine the basic links, or edges, of each network actor from all five dimensions of collaboration explored in this study. This analysis method aligns with the strategy used in other non-directional, network collaboration studies (Chang, Hung, Lin & Su, 2013; Zhou, Zeng, Fan & Di, 2018).

This information is important for the study since the SHRAC CI initiative is fairly new, and it is important to identify the central figures in the network as they may be driving information flow at this early stage of the network. Studying this pattern is deemed a critical first step when studying networks (Freeman, 2004; Opsahl, Agneessens & Skvoretz, 2010). Degree centrality for undirected networks is formally defined as,

$$k_i = \sum_{j}^{n} x_{ij}$$

where, *i* refers to a single organization and *j* refers to all other organizations. x_{ij} is defined as 1 if node *i* is connected to node *j*, and 0 otherwise. Additionally, *n* refers to the number of organizations in SHRAC (Opsahl et. al., 2010). The calculation of degree centrality quantifies activity for the organizations in the network (Ergün & Usluel, 2016). Organizations with high centrality scores are well connected and can be

considered central actors in the collaboration. Degree centrality and density were calculated in UCINET©. Scores would range from 0 (no connections to any other organization) to 22 (connected to all other organizations in the committee).

2.4. Results

Survey responses were collected from 57% of SHRAC organizations (n=13). Figure 1 provides an overview of Sleep Tight Hampton Roads' representation from major sectors. Most respondents were from the healthcare sector (53.9%), followed by nonprofit (15.4%), social services (15.4%), community organization (7.7%), and government (7.7%). The majority of respondents also reported working directly with the Hampton Roads community daily/almost daily (61.5%) followed by weekly/almost weekly (15.4%), monthly/almost monthly (7.7%), every few months (7.7%), or once or twice (7.7%), over the last 12 months. Additionally, a small portion, 7.7%, reported never working directly with the community. All respondents (100%) strongly agreed or agreed their organization's vision matched Minus 9 to 5's vision that "Each family in Hampton Roads will be equipped and supported to raise children who are healthy, thriving, and ready to learn." In addition, all respondents (100%) believed that their respective organization was achieving its intended results related to infant safe sleep in the Hampton Roads community.

2.4.1. ION Network Findings

Network density scores (density ± SD) were as follows: 0.43 ± 0.50 for information sharing, 0.10 ± 0.30 for technical assistance, 0.19 ± 0.52 for jointly planning, 0.11 ± 0.31 for sharing resources, and 0.18 ± 0.38 for MOA/contracts. These

scores represent a proportion of ties. This means a network density of 0.20 refers to a network where there are approximately 20%, or 1 in 5, of all potential ties present among organizations. The average network density for the specific collaboration domains ranged from 10% to 43%. Figure 1 depicts network diagrams for each of the five collaboration dimensions, including network density values (density ± SD). The network diagrams for sharing information, technical assistance, and jointly planning domains include frequency of interactions so the ties depicted vary in thickness based on increased frequency. Diagrams for sharing resources and MOA do not have variations in frequency so the ties indicate simply if these relationships exist or not.

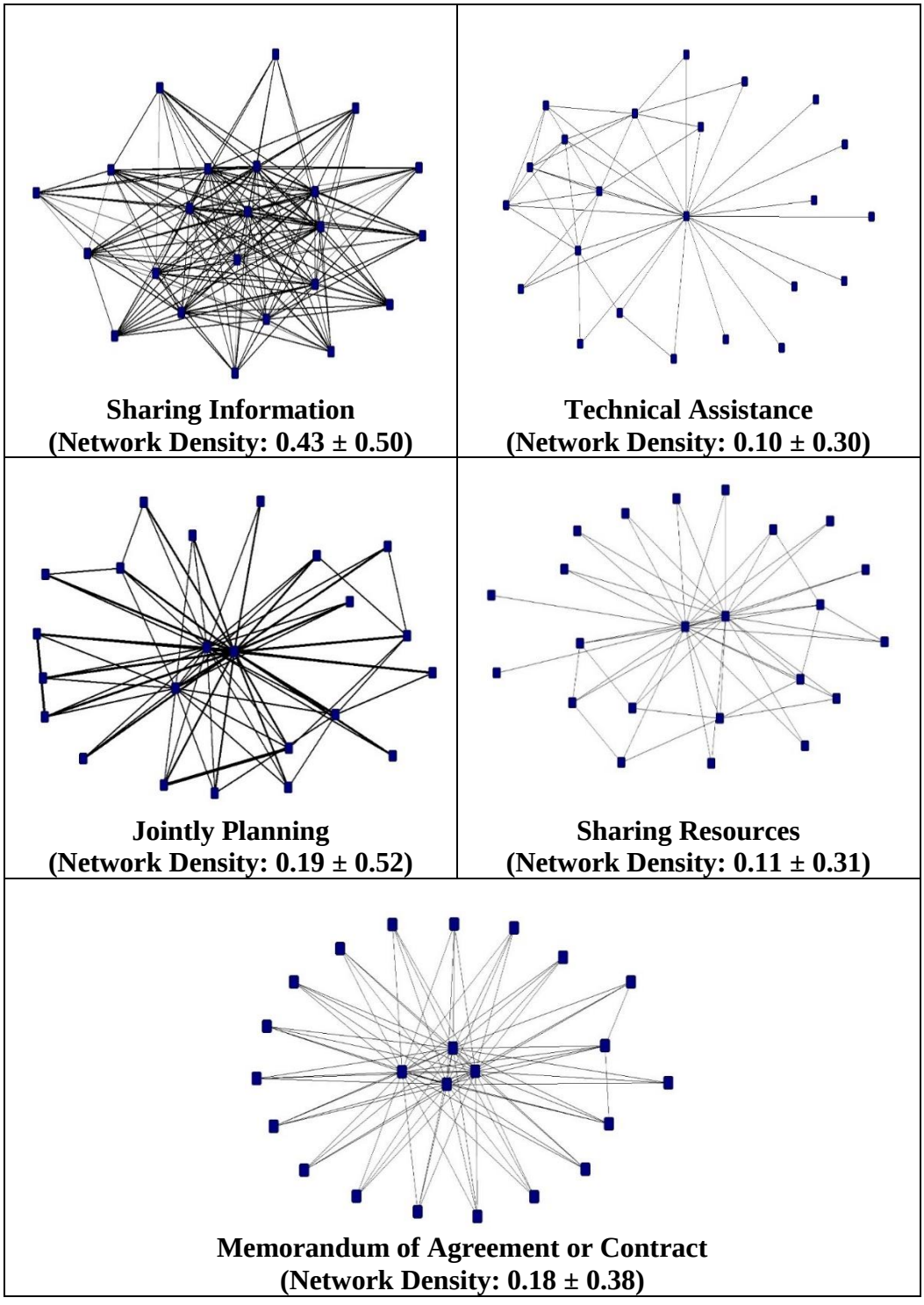


Figure 2-1: Collaboration Network Diagrams Depicting Collaboration Among SHRAC CI Members

To further examine the connections of each organizations in the context of specific stages of collaboration, degree centrality was calculated for the five collaboration domains. Degree centrality scores are summarized by organization in Table 2. The total number of ties or connections possible was 22. Organizations had a range of 6-22 ties with an average of 15.13 for information sharing; 1-8 ties with an average of 4.09 for technical assistance; 3-15 ties with an average of 5.74 for joint planning; 2-22 ties with an average of 4.35 for sharing resources; 3-22 ties with an average of 7.13 for MOUs.

Table 2-2: Degree Centrality Scores for Organizations in the Sleeptight Hampton Roads Advisory Committee

Organization ID	Degree Centrality (DC) Score by Collaboration Domain				
	Sharing Information	**Technical Assistance**	**Jointly Planning**	**Sharing Resources**	**MOA or Contract**
Organization A	22	22	3	2	4
Organization B	11	1	4	3	4
Organization C	14	3	22	4	3
Organization D	14	2	5	4	4
Organization E	9	1	4	2	4
Organization F	9	1	2	2	4
Organization G	20	3	21	4	20
Organization H	22	8	15	19	22
Organization I	11	5	3	3	4
Organization J	22	7	3	22	4
Organization K	19	6	5	6	6
Organization L	11	5	3	3	5
Organization M	9	1	2	1	4
Organization N	19	8	3	4	4
Organization O	11	2	4	2	4
Organization P	18	8	5	5	4
Organization Q	10	1	3	3	4
Organization R	21	3	4	2	22
Organization S	22	2	4	2	4
Organization T	9	1	3	1	4
Organization U	6	1	3	2	4
Organization V	21	1	4	2	22
Organization W	18	2	7	2	4
Avg. DC ± Std. Dev.	15.13 ± 5.35	4.09 ± 4.56	5.74 ± 5.49	4.35 ± 5.15	7.13 ± 6.62

2.5. Discussion

Committee characteristics captured in the non-ION survey questions demonstrate that, at this time, most committee members worked directly with the Hampton Roads community. In addition, for those that did work with the community, it was frequent. This finding suggests that there is a strong common agenda in the committee's CI approach (Wolff et. al., 2017). This is also supported by the indication that the majority of organizations state that their own organization's mission matches Minus 9 to 5's mission.

The network measures describe the extent of collaboration occurring in the partnership. The average densities, ranging from 10% for technical assistance to 43% for information sharing, show that, in terms of collaborative activities and links, SHRAC members are not densely connected (Borgatti, 2005). Dense networks in the field of community health are advantageous for coordination of activities and other partnership efforts (Hawe, Webster & Shiell, 2004). However, networks with low density can be advantageous for individual members, since they may have access to a more expansive variety of information, skills, and opportunities (McGloin, Sullivan & Thomas, 2014). The low density scores in this analysis are unsurprising given the newness of the committee. The highest density score (0.43) was for the information sharing network, which may be due to the fact this activity is a basic level of collaboration that can more easily and frequently be achieved. As SHRAC develops as a network, more complex or formal forms of collaboration may not exist at this time, particularly among cross-sector organizations who have never worked together in any capacity before joining this

initiative. The scores can indicate that some individual network members may be working with specific organizations and not others to collaborate in SHRAC activities. Degree centrality scores in this analysis indicate that some organizations are more central players in the network. Two organizations in particular, labeled Organizations G and H, received the highest degree centrality scores across three of the five collaboration domains, including sharing information, jointly planning, and MOA or contract. However, neither of these organizations is the backbone organization of the CI initiative. These organizations, particular if demonstrating this same role over time, may be the organizations that the backbone organization could use as "leverage points" in the partnership, as these may be important for information flows (Borgatti, 2005). Contrary to what is expected in a CI initiative, this finding indicates that these organizations, rather than the backbone organization, may be the partners that other members communicated with more intensively (Valente et. al., 2008).

Taken together, these ION findings provide a cross-sectional view on CI in practice, particularly in regards to how CI elements of shared measurement, continuous communication, common agenda, mutually reinforced activity, and a backbone organization exist in practice. This analysis, which implements an external shared measurement approach of examining collaboration, demonstrates that the SHRAC CI engages in continuous communication across many forms of collaboration and is committed to a common agenda. Given this finding, we can also determine a level of mutually reinforced activity ongoing because of collaboration. However, future research on CI member productivity or network impact would be useful to determine to the extent

this activity is taking place, as well as whether there is any form of shared measurement within the CI to track progress towards the common agenda. Finally, while a backbone organization exists within SHRAC, other organizations are currently more central. This finding could demonstrate the nuances of a role of a backbone organization in regards to collaboration. In order to inform CI planning, future research can explore the role of a CI backbone organization, specifically whether it should exist more as a facilitator of collaboration, rather than a key CI collaborative player.

There are a few limitations to the study. Due to the self-reported data, we are unable to confirm to what extent the committee members work with members of the community directly and how frequently in order to provide context on any mutually reinforcing activities towards toward the CI's common agenda. However, it must be noted that due to the new nature of the committee, other forms of data that could support collaboration, such as program documentation, do not exist in a consistent enough manner yet for a sound review. Additionally, study data is collected and analyzed at one time point with no comparison group. Given that literature of CI collaboration is limited, this study provides an exploratory insight on collaboration and allows for future research on collaboration over time to study patterns as well as comparisons to other groups in the field.

2.6. Conclusion

This study is novel in that it examines CI from the standpoint of collaboration. In the early programmatic state, it is meaningful to understand the functioning of organizational members towards a mission, rather than direct impacts on the target

population. When studying the organizational members of CI as the unit of analysis, the information from this study can be helpful to local leaders to understand how organizations may play different roles in various collaboration contexts. Given the cross-sectional nature of this study, the information presented also as a baseline assessment for Sleeptight Hampton Roads so future studies can examine how the committee characteristics and ION dimensions may evolve over time. Planned future research will examine how the network(s) evolve over time and to what extent there are also changes to CI collaboration and community impact over time.

3. NETWORK CHANGE AND TRANSFORMATAION IN A MULTISECTOR INFANT SAFE SLEEP NETWORK

3.1. Introduction

Sleep-related infant deaths continue to remain an issue in many communities in the United States. Interventions to address major causes of these deaths, including Sudden Infant Death Syndrome (SIDS) and Accidental Suffocation and Strangulation in Bed (ASSB), often take the form of community-level public health interventions (Levandowski, Sharma, Lane, Webster, Nestor, Cibula & Huntington, 2006; Ward & Balfour, 2016). These interventions are often pursued to incorporate various skillsets and resources to address the complexities of the socioecological influences on unsafe infant sleep habits (Nyarko, Lopez-Camelo, Castilla & Wehby, 2013). Thus, interventions often incorporate different types of people or organizations that can pool together knowledge and resources to better address risk factors associated with infant deaths and promote safe sleep habits for families that may be most at risk (Hayes, Calhoun, Joseph, Farnsworth & Arakaki, 2016; Nyarko, Lopez-Camelo, Castilla & Wehby, 2013).

While interorganizational infant safe sleep interventions have been considered successful in changing targeted infant and family health behaviors (Ward & Balfour, 2016), evidence suggests that the passage of time is necessary to ensure effective diffusion of information and resources between organizational members of these types of networks (Kaminski, 2011; Rogers, 2003). The diffusion of such innovations is important as it leads to the transference of health promotion programs and program elements to new settings through stages of diffusion (Steckler, Goodman, McLeroy,

Davis & Koch, 1992). Innovation diffusion creates an increased likelihood of program permanence through this transference process (Goodman, McLeroy, Steckler & Hoyle, 1993). Specifically, Yin describes how, when innovations transfer, they are routinized after organizational events, or passages, take place (Yin, 1978). Then, when institutionalized into a new organization, program implementation is optimized in a process called niche saturation (Goodman, McLeroy, Steckler & Hoyle, 1993). The literature indicates this program institutionalization process takes place across a variety of health promotion programs, including those that involve organizational networks (Bracht, Finnegan Jr, Rissel, Weisbrod, Gleason, Corbett & Veblen-Mortenson, 1994; Pluye, Potvin, & Denis, 2004; Shediac-Rizkallah & Bone, 1998). Furthermore, these networks can evolve to include collaboration with new, non-network members that could potentially provide novel ideas and build capacity of organizations to carry out and institutionalize interventions (Lundblad, 2003; Robinson, 2009).

3.1.1. Network Theory & Transformation

From a general perspective, interorganizational networks (ION) that work together to address complex, community-level issues are a modality of diffusion of innovations (Valente, 2012). Diffusion of innovation theory provides the perspective on how new ideas and practices may spread within a given network. The diffusion of innovations involves four major elements: Innovation, Communication Channels, Social System, and Time (Dearing, 2009; Rogers, 1995; Rogers, 2010). Here, innovation is broadly defined as any idea or practice that is new to an "adopter." Adopters in the interorganizational network would refer to organizations within a collaboration that is

adopting any new information or materials through collaborative activities (Lundblad, 2003). In the context of community health interorganizational networks, this could take the form of collaborative actions such as the sharing of information or receiving technical assistance, sharing resources, joint planning of activities, or formal partnership through a memorandum of agreement (MOA) or contract (Garney, Patterson, Garcia, Muraleetharan & McLeroy, 2020). These actions could qualify as a mechanism for innovation exchange, particularly as in a recently formed interorganizational network, most types of collaborative activities could be considered as innovation exchange (Lundblad, 2003).

Communication channels, defined as "links" in a network, are pathways for communication to lead to collaboration between organizations (Rogers, 1995; Rogers, 2003). Within the aforementioned collaboration domains, communication channels exist within each type of domain, though may differ between different types of collaboration (Dearing, 2009). Currently, there is a gap in research on whether some types of collaboration may remain or are prioritized over time rather than others. The social system in diffusion of innovation theory in a network refers to both internal and external influences on innovation diffusion. That is, internal influence could refer to influences that exist within a predefined network of collaborators, i.e., membership within a given network. External influences may be new partners that emerge naturally through external collaboration or a need for strengthened capabilities (Lundblad, 2003).

Finally, time within the diffusion of innovation theory refers to the necessity to the passage of time to create change within a community towards the common agenda of

an intervention (Rogers, 1995). This final aspect is the focus of the present study as a predictor in network change. Deviating from traditional diffusion of innovation research, this study also explores how a given network may not only change, but also transform over time. A growing body of research examines how entry into or out of ION relationships becomes a strategic option of community interventions that are attempting to strengthen their capabilities (Kim, Oh & Swaminathan, 2006). However, given the embedded nature of interorganizational ties, particularly in predefined networks, this assumption in network transformation is limited. In addition, minimal research exists on these theoretical underpinnings of network collaboration growth and transformation within infant safe sleep network interventions in practice.

3.1.2. Study Population & Purpose

Given these knowledge gaps in network changes and potential expansion, this study seeks to examine how one safe sleep intervention evolves in collaboration patterns over time. The intervention in this study is the Sleeptight Hampton Roads Advisory Committee (SHRAC), implemented by a collective impact initiative in the Hampton Roads region of Virginia. SHRAC was convened in 2016 in response to a high prevalence of low-birth weight health issues and premature mortality among newborn babies in the Hampton Roads region of Virginia. This region includes Chesapeake, Norfolk, Portsmouth, Suffolk, and Virginia Beach, with SHRAC partners spanning across all areas of the region.

SHRAC is an ideal network intervention for this study because it was recently formed and just started new programmatic activities. This means that collaborative

activities that take place would involve diffusion of innovation processes in the sense that the organizations have not worked together prior to SHRAC on the mission of increasing infant safe sleep in the Hampton Roads region. Additionally, given a partnership with SHRAC, data can be collected over time on ION collaboration to directly examine any network changes. Finally, SHRAC focuses on using a multi-level strategy to create a culture of infant safe sleep in the region through collaboration, partnership, and collective action by means of educational and community resource sharing activities. These aspects make SHRAC a population of interest not only for this study but the field at large. The purpose of the present study is to build an understanding on network changes and transformations in SHRAC over 12 months of programmatic development. The research question this study seeks to answer is to what extent does the SHRAC network change and transform over 12 months of program development.

3.2. Methodology

This study examines changes in the SHRAC after approximately one year of programmatic development and implementation between 2018 and 2019. Similar to a social network analysis (SNA), this study specifically examines aspects of and changes in relationships between organizations using an ION analysis. In an ION analysis, rather than an individual, an organization is the unit of analysis (Bergenholtz, & Waldstrøm, 2011). Whereas in an SNA, an individual is a node, in the SHRAC ION, each SHRAC organizational member acts as a node in the network (Borgatti, Mehra, Brass & Labianca, 2009).

A network node is defined as an individual actor in a given network (Valente, 2012). When examining the SHRAC network from the diffusion of innovation perspective, nodes are equivalent to innovation adopters. Relationships between nodes are defined as links, which are novel interactions or defined relationships between the nodes (Valente, Palinkas, Czaja, Chu, & Brown, 2015). Links are examined through collaboration activities conducted through communication channels. However, the collaboration, itself, will be examined rather than channels, given that the focus of the study is change in collaboration, not the medium for collaboration.

The ION analysis in the present study will examine node and link attributes and changes over time using a relational dataset created from SHRAC ION data collected between Spring/Summer 2018 and Spring 2019. The network boundaries are thus defined using a position-based boundary specification approach, where boundaries of the network are limited to membership in SHRAC as defined by a roster developed and maintained by staff (Marin & Wellman, 2011). The network measures are examined using a whole network approach to evaluate any macro-level changes in the network relationships (Knoke & Yang, 2019). Additionally, the analysis will examine any new ION relationships that emerge during an organization's membership in SHRAC. These relationships will be examined from an ego-perspective, where we study SHRAC network actors' new relationships from an individual perspective, thinking of the SHRAC organization as a central figure with links to new, non-SHRAC members (Mcauley & Leskovec, 2014).

3.2.1. Data Collection

Network data can come from a variety of sources, and thresholds for data validity and reliability are variable (Valente, 2012). However, evidence suggests that network survey data collection is reliable, particularly if survey respondents are given a list of organizations in the data collection tool (Valente, 2012). The ION survey used in this analysis includes all organizational names of other members in from a roster which enhances reliability of the data.

The ION survey was implemented to all organizational members of SHRAC (N=23) in Spring 2018 and again in Spring 2019 (IRB2018-0522). The survey focuses on specific dimensions related to collaboration to capture SHRAC ION characteristics over time. These dimensions examined included information sharing, knowledge transfer through technical assistance; jointly planning, coordinating, or conducting activities, trainings, or events; sharing tangible resources; and sharing a formal MOA or contract (Clark, Ramirez, Drake, Beaudoin, Garney, Wendel & Player, 2014; Davis, Koroloff & Johnsen, 2012; Kegler et. al., 2012; Singer & Kegler, 2004; Garney et. al., 2020). The literature describes these dimensions as ways to measure collaboration based on stage and intensity (Singer & Kegler, 2004). That is, the act of sharing information between network members demonstrates the most basic type of collaboration, and having a formal working relationship documented through a contract or MOA demonstrates a more developed stage of collaboration (Clark et. al., 2014; Singer & Kegler, 2004). These collaboration dimensions, including sharing information, jointly planning, sharing tangible resources and sharing a formal MOA, are based on the

community health literature (Clark et. al., 2014; Singer & Kegler, 2004). This study also included the added dimension of knowledge transfer through technical assistance, as training and technical assistance can often be a major aspect of collaborative community health initiatives (Davis et. al., 2012; Valente et. al., 2007).

In addition to relationships with SHRAC members, organizations were asked to list other organizations (beyond those on the provided roster) that they work with on activities pertaining to the SHRAC mission of infant safe sleep. Specifically, respondents were asked the following, "In addition to the organizations previously listed, do you work closely with any other organizations on activities related to infant safe sleep?" Respondents were able to provide open-text responses to this question. If respondents provided any organization(s) they were then prompted to answer whether they had engaged in any of the five collaboration dimensions with these other organizations.

3.2.2. Data Analysis

ION responses were exported from Qualtrics, and assigned numeric values. An assumption of reciprocity and mutualism was applied to all five ION measures. This means that there was no directionality of relationships in any of the collaboration dimensions (Clark et. al., 2014; Schoen, Moreland-Russell, Prewitt & Carothers, 2014). The responses of the survey were entered into a relational matrix with the frequency-ranked collaboration recoded for the information sharing, knowledge exchange through technical assistance, and jointly planning dimensions (Borgatti, 2003). In other words, frequency of interactions (i.e., Once or twice, Every few months, Monthly/almost

monthly, Weekly/almost weekly, Daily/almost daily) would receive a numerical rank that ranged from 1 to 5. For the non-frequency dimension, answers received a rank of 1 or 0 as these were binary "yes" or "no" questions. UCINET© network analysis software was used to analyze all network data with Netdraw used to create network diagrams and visualize the relationships (Borgatti, Everett & Freeman, 2002). Network measures of interest in this analysis included network density and node degree centrality.

3.2.2.1. Network Density

Density examines the extent of connectivity between organizations in a network as a proportion of all probable ties in the network (Ergün & Usluel, 2016). This measure was calculated overall for the whole network, rather than individual network actors. Density was calculated for all five collaboration domain survey questions, treating each as an independent network, so that connectivity in each collaborative activity was examined individually. Density is calculated as such,

$$D = \frac{l}{n * (n - 1)}$$

where, *l* refers to the number of links in a network and *n* refers to the number of organizations in SHRAC (Valente, Chou & Pentz, 2007). More simply, density is calculated as the proportion of existing ties to the number of all possible ties that can exist in a given network.

To calculate, the rank values in the collaboration matrices were replaced with a 1, indicating some sort of link between the organizations. Where there was no type of relationship, the score was a 0, indicating no relationship. The value calculated would

provide overall density of the network, with a network density value of 1 indicating that each organization is connected to all other organizations in some capacity.

3.2.2.2. Degree Centrality

In network analysis, there are many types of centrality calculations, which provide variations on positional data for actors in a given network. The most frequently used centrality measures include degree, closeness, betweenness, and eigenvector (Valente, Coronges, Stevens & Cousineau, 2008). For the purposes of this study, we focus on the degree centrality measure. Here, degree centrality scores provide organizational-level data on who has the most ties or links to other organizations, indicating which organizations may hold more information or can connect to others more quickly. Effectively, degree centrality is measuring a level of connectedness among organizations as a sum of ties to other organizations.

Centrality measures, including degree centrality, generally assume a network that is both undirected and dichotomous, or unweighted (Bell, Atkinson & Carlson, 1999; Wasserman & Faust, 1994). Degree centrality can also be calculated as in-degree or out-degree in directed networks. For directed networks, in-degree centrality includes the number of connections that point inward at a network actor, and out-degree centrality includes the number of connections that originate from a network actor and point outward (Hansen, Shneiderman & Smith, 2011). Given that reciprocity was applied to the data, degree centrality is calculated from the traditional, non-directional perspective. The theoretical underpinnings of this allow us to examine the basic links, or edges, of each network actor from all five dimensions of collaboration explored in this study. This

analysis method aligns with the strategy used in other non-directional, network collaboration studies (Chang, Hung, Lin & Su, 2013; Zhou, Zeng, Fan & Di, 2018). This information is important for the study since the measure allows us to identify the central figures in the network as they may be driving information flow at this early stage of the network. Studying this pattern is deemed a critical first step when studying networks, particularly in network relationships changes (Freeman, 2004; Opsahl, Agneessens & Skvoretz, 2010). Degree centrality for undirected networks is formally defined as,

$$k_i = \sum_{j}^{n} x_{ij}$$

where, *i* refers to a single organization and *j* refers to all other organizations. x_{ij} is defined as 1 if node *i* is connected to node *j*, and 0 otherwise. Additionally, *n* refers to the number of organizations in SHRAC (Opsahl et. al., 2010). The calculation of degree centrality quantifies activity for the organizations in the network (Ergün & Usluel, 2016). Organizations with high centrality scores are well connected and can be considered central actors in the collaboration. Degree centrality and density were calculated in UCINET©. Scores would range from 0 (no connections to any other organization) to 22 (connected to all other organizations in the committee).

3.3. Results

Survey responses were collected from majority members of the SHRAC network (N=23). In 2018, 74% of SHRAC organizations responded to the ION survey (n=17),

followed by 57% (n=13) in 2019. In both years, the same member of each organization, when possible, completed the survey to ensure consistency in response type.

3.3.1. ION Network Findings

Whole network density scores (density ± SD) were as follows: 0.46 ± 0.50 for information sharing in 2018 to 0.43 ± 0.50 in 2019, 0.26 ± 0.44 to 0.10 ± 0.30 for technical assistance, 0.37 ± 0.48 to 0.19 ± 0.52 for jointly planning, 0.27 ± 0.44 to 0.11 ± 0.31 for sharing resources, and 0.21 ± 0.41 to 0.18 ± 0.38 for MOA/contracts. The average network density for the specific collaboration domains ranged from 0.21-0.44 in 2018 (21-44% of all possible ties in a network) to 0.10-0.43 in 2019 (10-43% of of all possible ties in a network).

The drop in network is seen primarily in the domains of technical assistance, jointly planning events, sharing resources, while sharing information and sharing a formal memorandum of agreement or contract between members stayed relatively same throughout one year of the initiative. Figure 1 depicts network diagrams for each of the five collaboration dimensions, including network density values (density ± SD). The network diagrams for sharing information, technical assistance, and jointly planning domains include frequency of interactions so the ties depicted vary in thickness based on increased frequency. Diagrams for sharing resources and MOA do not have variations in frequency so the ties indicate simply if these relationships exist or not.

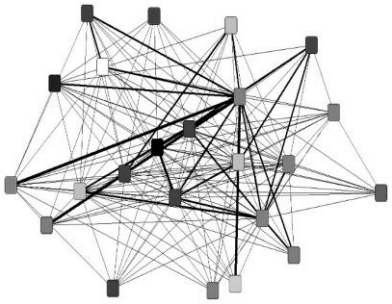
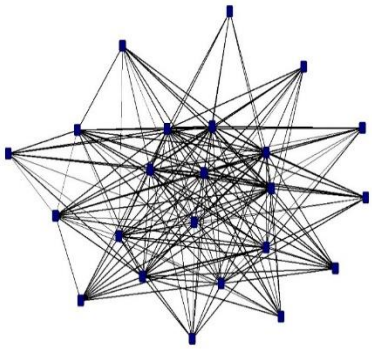
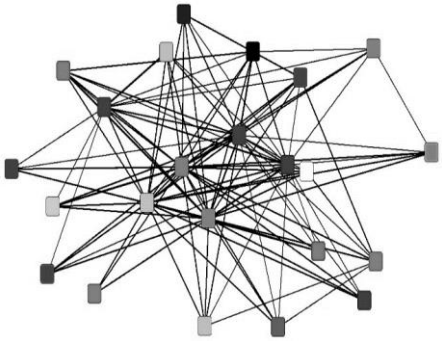
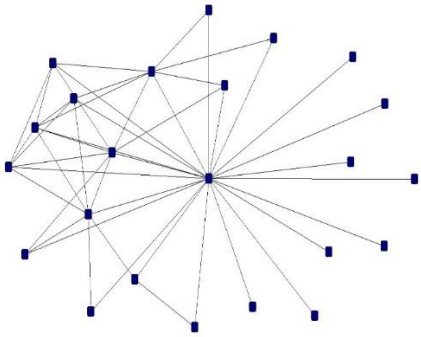
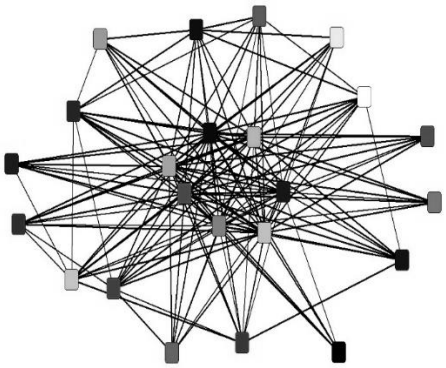
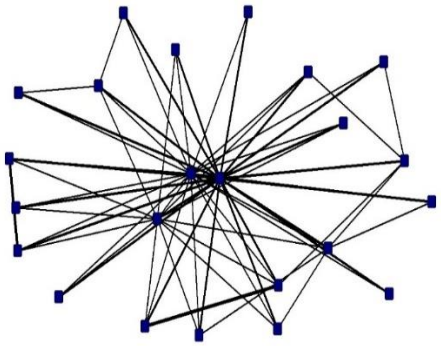
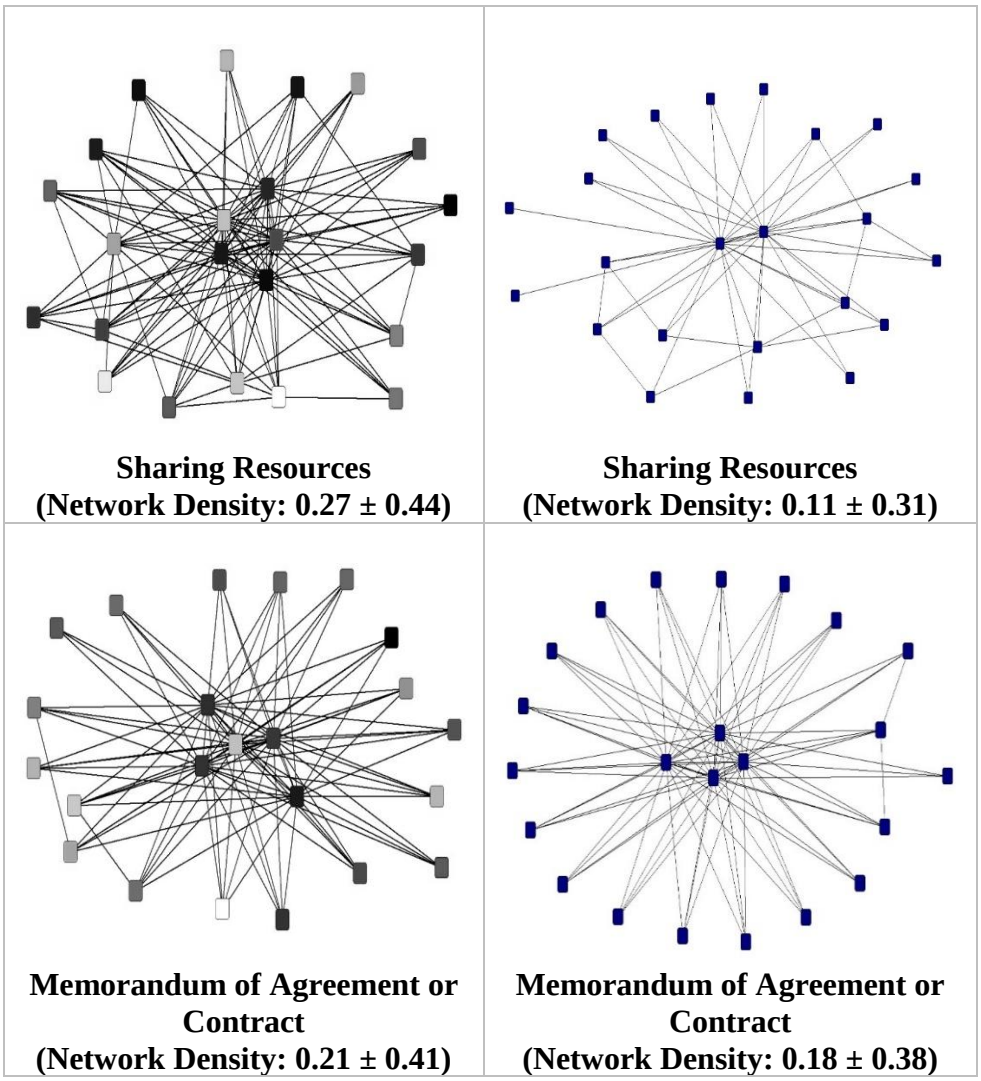
2018	2019
	
Sharing Information (Network Density: 0.46 ± 0.50)	**Sharing Information (Network Density: 0.43 ± 0.50)**
	
Technical Assistance (Network Density: 0.26 ± 0.44)	**Technical Assistance (Network Density: 0.10 ± 0.30)**
	
Jointly Planning (Network Density: 0.37 ± 0.48)	**Jointly Planning (Network Density: 0.19 ± 0.52)**

Figure 3-1: Network Diagrams Depicting Collaboration among Organizations in the Sleeptight Hampton Roads Advisory Committee between 2018-2019



Sharing Resources (Network Density: 0.27 ± 0.44)

Sharing Resources (Network Density: 0.11 ± 0.31)

Memorandum of Agreement or Contract (Network Density: 0.21 ± 0.41)

Memorandum of Agreement or Contract (Network Density: 0.18 ± 0.38)

Figure 3-1 Continued.

To further examine the positional value of the organizations in the context of specific stages of collaboration, degree centrality was calculated for the five collaboration domains. Average degree centrality within the sharing information (T1: 14.78 ± 5.71, T2: 15.13 ± 5.35) and MOA/contract networks (T1: 8.43 ± 6.69, T2: 7.13 ± 6.62) remained relatively the same across a year. However, there were declines in average degree centrality in technical assistance (T1: 9.65 ± 5.36, T2: 4.09 ± 4.56), jointly

planning (T1: 13.13 ± 5.98, T2: 5.74 ± 5.49), and sharing resources (T1: 10.35 ± 6.26, T2: 4.35 ± 5.15) networks. The largest changes across the year included Organizations A, G, K, M & R. The changes in Organizations A and K are significant in that they received the highest degree centrality scores across four out of five of the collaboration measures in 2018. Degree centrality scores for 2018 and 2019 are summarized by organization in Table 2.

Table 3-1: Degree Centrality Scores for Organizations in the Sleeptight Hampton Roads Advisory Committee

Organization ID	Degree Centrality (DC) Score by Collaboration Domain									
	Sharing Information		Technical Assistance		Jointly Planning		Sharing Resources		MOA or Contract	
Data Collection Year	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
Organization A	22	22	22	22	22	3	22	2	6	4
Organization B	8	11	5	1	11	4	10	3	6	4
Organization C	22	14	9	3	6	22	5	4	5	3
Organization D	13	14	7	2	11	5	9	4	5	4
Organization E	10	9	6	1	10	4	8	2	5	4
Organization F	9	9	5	1	7	2	5	2	5	4
Organization G	21	20	19	3	22	21	22	4	21	20
Organization H	20	22	20	8	12	15	20	19	22	22
Organization I	9	11	9	5	8	3	7	3	5	4
Organization J	22	22	6	7	22	3	7	22	5	4
Organization K	21	19	21	6	22	5	22	6	22	6
Organization L	9	11	7	5	10	3	8	3	4	5
Organization M	18	9	21	1	21	2	5	1	5	4
Organization N	15	19	6	8	8	3	6	4	6	4
Organization O	11	11	5	2	9	4	7	2	4	4
Organization P	13	18	8	8	12	5	9	5	4	4
Organization Q	10	10	3	1	9	3	7	3	5	4
Organization R	22	21	14	3	22	4	22	2	22	22
Organization S	10	22	6	2	9	4	5	2	5	4
Organization T	10	9	6	1	7	3	5	1	4	4
Organization U	10	6	5	1	8	3	7	2	5	4
Organization V	13	21	6	1	12	4	6	2	18	22
Organization W	22	18	6	2	22	7	14	2	5	4
Avg. DC ± Std. Dev.	14.78 ± 5.71	15.13 ± 5.35	9.65 ± 5.36	4.09 ± 4.56	13.13 ± 5.98	5.74 ± 5.49	10.35 ± 6.26	4.35 ± 5.15	8.43 ± 6.69	7.13 ± 6.62

Finally, new relationships were examined based on the survey question specific to new relationships initiated with non-SHRAC members. Relationships were included if the SHRAC organization reported them in either year of data collection. Organization H reported the greatest number of new relationships (n=8), with a split between relationships in 2018 (n=5) and 2019 (n=3), followed by Organization P which had the greatest number of new relationships in 2019 (n=4). Organization H and P also maintained a level of collaboration with Partners D and E across both years. Additionally, across both years, sharing information, technical assistance, and jointly planning events remained the collaboration domains most reported in new partner relationships, with sharing information most often reported as the collaboration domain. Table 3 summarizes the relationships reported by Partner (new relationship) compared to SHRAC organization.

Table 3-2: New Organizational Relationships Reported by the Sleeptight Hampton Roads Advisory Committee from 2018-2019

		Collaboration Domain									
		Sharing Info		Technical Assistance		Jointly Planning		Sharing Resources		MOA or Contract	
New Partner	**SHRAC Member**	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**
Partner A	Organization H	X		X		X					
Partner B		X				X					
Partner C		X		X		X					
Partner D	Organization H	X	X	X		X	X				
	Organization P		X		X						
Partner E	Organization H	X	X		X		X				
	Organization P		X		X						
Partner F	Organization J			X							
Partner G	Organization L	X		X		X		X			
Partner H	Organization M	X		X		X					

Table 3-2 Continued.

Collaboration Domain											
		Sharing Info		Technical Assistance		Jointly Planning		Sharing Resources		MOA or Contract	
New Partner	**SHRAC Member**	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**
Partner I	Organization M							**X**			
	Organization W		**X**								
Partner J	Organization W	**X**						**X**			
Partner K	Organization H		**X**		**X**		**X**				
	Organization P		**X**		**X**						
Partner M	Organization H		**X**				**X**				
Partner N	Organization P		**X**		**X**						
Partner O	Organization W		**X**								

3.4. Discussion

These findings provide context to network changes and transformation of the Sleeptight Hampton Roads Advisory Committee and organizational members over time. To begin, we see that overall the collaboration across the various measures examined declined over one year of program development and implementation. Specifically, network density findings indicate that the existence of collaboration through the form of formal contracts remain, likely due to legal agreements, as well as the existence of information sharing. This assumption is based on the context provided by the collaboration domains. The MOAs/contract domain connotes some sort of legal tie between organizations, many of which can be longer-term in nature (Jarillo & Ricart, 1987). Additionally, as information sharing is considered the most basic level of collaboration (Clark et. al., 2014; Singer & Kegler, 2004), this type of collaboration may

be easier to maintain overtime. This information alludes to the idea that organizations may be more independently working towards the SHRAC mission while continuously sharing information, but requiring less support through activities such as technical assistance, jointly planning events, and sharing resources.

Across this 12-month analysis period, SHRAC members seemed to prioritize ongoing communication between organizations, as well as formal plans within MOAs/contracts if necessary, through the network (Loitz, Stearns, Fraser, Storey & Spence, 2017). Given the newness of the network, this finding could indicate that organizations needed to work more closely together, across all collaboration domains, in order to organize during the earlier stage of network development (Butterfoss & Kegler, 2009). As indicated in the discussion of the diffusion of innovation sharing information may then be considered the priority type of Communication Channel for members of SHRAC (Roger, 1995). However, it could also indicate that organizations were not as intimately involved with the committee as time progressed, which could speak to a decline in commitment. This may be an area where future research could explore.

As to be expected, degree centrality scores in this analysis indicate that some organizations are more central, or connected, to others in the network. However, the organizations that were most central differed across years. In 2018, these organizations were Organizations A and K and in 2019, the highest scores were Organizations G and H. Organizations A and K were among the organization that dropped centrality scores from 2018 to 2019, which means they were no longer the organizations that other SHRAC members communicated with more intensely or often.

This finding speaks to a level of network change when reviewing all collaboration domains in aggregate. Given the dynamicity of health networks, particularly newly established ones, this change is expected, particularly as this data represents a network over time. The degree centrality changes specifically indicate that collaboration in SHRAC is not controlled or directed by specific organization(s). Instead, in alignment with network density changes, centrality changes show a level of fluid collaboration among all members in the network (Batt & Purchase, 2004).

In regards to how this information may be associated with the new relationship information, Organization H, which became one of the more central organizations in 2019 was also the organization that reported the highest number of new relationships across 2018 and 2019. This information indicates that Organization H is not only an integral member of the current SHRAC network, but also a key builder in the creation of new ties that may transform the network. Given that the existing SHRAC network over time remains low and becomes lower in connectedness (i.e., average network density), this could indicate that organizations may not only favor collaboration with select, central member(s) of the network, but may also utilize Organization H as a bridge to new information that may not exist already in the network (Granovetter, 1977).

When considering this information within the Diffusion of Innovation theory, we consider the role of Organization H, due to its role across both years of data collection, as an internal influence communication channel that draws connection to external influences (Rogers, 1995; Rogers, 2003). Additionally, through the overall prevalence of new relationships, it is evident that the social system of organizations that work towards

infant safe sleep does not stay within the predefined parameters of SHRAC membership, and may in fact see a shift over time through means of network transformation (Kim et. al., 2006). However, this shift in collaboration may be limited to key domains, such as the basic level of information sharing, as findings indicate that not only are domains such as technical assistance, jointly planning, sharing resources, and MOA's not initiated with non-network members, they also are not as maintained over time.

There are limitations to this study. Given that the focus of this study was the ION and not the community, we are unable to determine to what extent the committee members work with members of the community directly and how frequently. Additionally, due to the new nature of the committee, other forms of data that could be used to verify the self-reported responses, such as program documentation, do not exist in a consistent enough manner yet for a sound review and comparison across the two time points of data collection. Additionally, while two time points of data were able to be collected from this interorganizational network, future research that collects data over a longer span of time may provide more context to overall network change and transformation through the establishment of new ties and partners.

3.5. Conclusion

This study is meaningful in that it explores how aspects of an infant health network change over time in relation to predefined network characteristics, as well as network transformation to include new ties. This information is useful from a planning perspective for such networks, particularly in the field of infant health, where networks often emerge and exist to tackle the issues that feed into this complex health challenge at

the community. Organizations in such networks continue to play different roles in various collaboration contexts.

Additionally, given the passage of time as is described in the Diffusion of Innovation Theory, we understand that shifts can occur in many ways. As depicted in this analysis, the shifts occurred not only in the role of organizations playing more central role at a given time point, but also in what types of Communication Channels persist. Specifically, we learn how some types of Communication Channels are prioritized over time and how a network can transform through these aspects from a network structure perspective.

4. INDICATORS OF ORGANIZATIONAL PRODUCTIVITY IN A COMMUNITY HEALTH NETWORK

4.1. Introduction

The public health field involves many complex health challenges, ranging from complications of chronic diseases in older adults to early issues of infant safe sleep in low-income populations (Chang & Liu, 2008; Levandowski, Sharma, Lane, Webster, Nestor, Cibula & Huntington, 2006; Ward & Balfour, 2016). Addressing these issues involves equipping the public health workforce with a range of skillsets and resources to address the complexities of the socioecological influences on health (Nyarko, Lopez-Camelo, Castilla & Wehby, 2013). While a skilled workforce is beneficial, real-world application can be confined by limitations such as public health funding. Globally, budgetary restrictions in healthcare and social services create a need to deliver public health services using strategies that increase productivity towards addressing health issues within financial constraints (Stuckler, Basu, & McKee, 2010). These approaches should leverage existing resources and personnel in ways that lead to meaningful impact in communities.

One such approach involves using community partnerships in the form of public health networks. Cross-sector community partnership in the field are desirable in that they can lead to positive community-level health impacts, as well as value to partner members, demonstrating a good return on investment (Rowe, Nowak, Quaddus, & Naude, 2014). Specifically, evidence indicates that pooling resources, skill sets, and capabilities from partner organizations yield more productive results toward a given

public health mission (e.g., increasing infant safe sleep habits in a community) compared to that of individual organizations (Giachello, Arrom, Davis, Sayad, Ramirez & Nandi, 2003; Wolff, Minkler, Wolfe, Berkowitz, Bowen, Dunn Butterfoss, Christens, Francisco, Himmelman & Lee, 2017). While there is a robust understanding of total network effectiveness in the field, there is limited research on how individual productivity within these networks contribute to overall success. This study seeks to understand the functioning of a public health network by individual organizational productivity towards a mission, and whether there may be indicators driving organizational productivity within a network.

4.1.1. Productivity in Public Health Networks

In the field of public health, particularly with respect to interventions focused on vulnerable populations, productivity is often studied in relation to program delivery through employee performance (Chang & Liu, 2008; Jaskiewicz & Tulenko, 2012; Meessen, Kashala & Musango, 2007). These studies describe characteristics such as knowledge, skills, attitudes, motivation, and innovative behaviors as associated with individual productivity (Chang & Liu, 2008; Meessen et. al., 2007). The present study goes beyond the individualistic framing of production to understand productivity within a public health network. Specifically, the study seeks to examine whether an organization's role in an interorganizational network may be associated with productivity.

Theoretically, some lessons learned from employee productivity in organizations could be applied to organizational productivity in a health network. For example,

research indicates that investments in leaders of organizations can lead to increased and sustained productivity, both individually and overall, due to the central position these leaders have in an organization (von Thiele Schwarz, Hasson & Tafvelin, 2016). Outside of the community health field, general organizational productivity studies draw similar conclusions on how individual member attributes such as centrality may drive productivity (Moon, Quigley & Marr, 2012; Phipps, Prieto, & Ndinguri, 2013). This suggests that an individual actor's role in an organizational system may be an indicator of productivity. Thus, if an organization operates as a central actor in a network, this could potentially be advantageous both for the organization in terms of productivity, and for the overall network.

Productivity, as defined in this study, is specific to network mission. In public health, an organization's mission is a critical element in examining performance and productivity (Handler, Issel & Turnock, 2001). Within community partnerships in public health networks, missions are, as expected, community focused. Productivity towards community-focused missions are then measured through quantifying progress towards community impact (Ebrahim & Rangan, 2014). In the present study, we will examine productivity towards this impact through an examination of measurable goals within a community health network's mission.

4.1.2. Study Purpose

The purpose of this study is to bridge the understanding of public health productivity into an interorganizational network setting. Specifically, we want to understand whether central players in a network are more likely to be productive towards

the network's mission. The research question this study seeks to answer is whether degree centrality, or central influence of an organization, is associated with productivity towards a public health network's mission.

4.2. Methodology

To investigate this research question, data on the collaborative and productivity patterns of a network were collected from a survey. This survey was administered to a public health network (n=23) in 2019. Network members included organizations from multiple sectors working together to promote infant safe sleep in the Hampton Roads region of Virginia. The mission of this network was to "create a culture of infant safe sleep in the Hampton Roads region through collaboration, partnership, and collective action" (Minus 9 to 5, n.d.). The present study explores whether network characteristics predict organizational productivity towards this mission.

4.2.1. Data Collection

The study's survey was developed and administered using the online survey software, Qualtrics© (Qualtrics, 2019). This survey was distributed to organizational representatives of the network in Spring 2019 (IRB2018-0522). Network characteristics captured in the survey included the following five collaboration dimensions: information sharing; knowledge transfer through technical assistance; jointly planning, coordinating, or conducting activities, trainings, or events; sharing tangible resources; and sharing a formal memorandum of agreement or contract (MOA) (Clark, Ramirez, Drake, Beaudoin, Garney, Wendel & Player, 2014; Davis, Koroloff & Johnsen, 2012; Kegler et. al., 2012; Singer & Kegler, 2004). These specific dimensions were selected based on the

community health and network literature to effectively capture collaborative activities among public health partners (Singer & Kegler, 2004; Valente et. al., 2007; Davis et. al., 2012; Clark et. al., 2014).

Following the network survey questions included two survey questions to capture productivity of organizations over the past 12 months. The productivity questions in the survey were framed around the mission of the SleepTight Hampton Roads initiative. This mission statement is operationalized in two community impact goals. These goals are to provide 1) information, and 2) resources on infant safe sleep to vulnerable families in the Hampton Roads region (SleepTight Hampton Roads, n.d.). To capture efforts towards these two goals, the survey questions probed how frequently the individual members of the network have 1) provided information on safe sleep education to the Hampton Roads community over the past 12 months and 2) provided or donated resources to programs related to safe infant sleep over the past 12 months.

4.2.2. Data Analysis

A predictive analytics process was used to analyze productivity data using a quadratic assignment procedure (QAP) correlation analysis in UCINET© (Borgatti & Feld, 1994).This analysis procedure examines the strength of association between two variables in network science (Chon, 2004). The QAP analysis is utilized as a procedure in this study as degree centrality, a relationship-dependent network measure, is utilized as the independent variable across the five collaboration domains. QAP is a useful technique for this present study in that degree centrality violates the traditional statistical assumption of independence. QAP allows for a control of this interdependent measure

through the application of permutation tests. This procedure produces a bootstrapped null distribution of the network data by permutation of the nodes through randomization while maintaining network structures (Robins, 2015).

Predictive analytics in the field of network science involves applying a predictive (i.e., probability) score to an individual network actor to determine if there is an association with a given network measure and desired outcome (Abbott, 2014). One of the purposes of predictive analytics in network studies involves the building of a descriptive model (Delen & Demirkan, 2013). The statistical model employed for this study can provide a more structured understanding for what makes for more productive collaborators in a public health network. For the purposes of understanding the relationship, QAP correlations were conducted to examine the association between an organization-specific network measure, degree centrality, and the frequency of activities towards the two network goals (Kwak & Clayton-Matthews, 2002). The degree centrality variable in this analysis is described in more detail in the following section.

4.2.2.1. Centrality

In network analysis, there are many types of centrality calculations, which provide variations on positional data for actors in a given network. The most frequently used centrality measures include degree, closeness, betweenness, and eigenvector (Valente, Coronges, Stevens & Cousineau, 2008). For the purposes of this study, we focus on the degree centrality measure. Here, degree centrality scores provide organizational-level data on who has the most ties or links to other organizations, indicating which organizations may hold more information or can connect to others

more quickly. Effectively degree centrality is measuring a level of connectedness among organizations as a sum of ties to other organizations.

Centrality measures, including degree centrality, generally assume a network that is both undirected and dichotomous, or unweighted (Bell, Atkinson & Carlson, 1999; Wasserman & Faust, 1994). Degree centrality can also be calculated as in-degree or out-degree in directed networks. For directed networks, in-degree is the number of connections that point inward at a network actor and out-degree is the number of connections that originate from a network actor and point outward (Hansen, Shneiderman & Smith, 2011). Given that reciprocity was applied to the data, degree centrality is calculated from the traditional, non-directional perspective. The theoretical underpinnings of this allow us to examine the basic links, or edges, of each network actor from all five dimensions of collaboration explored in this study. This analysis method aligns with the strategy used in other non-directional, network collaboration studies (Chang, Hung, Lin & Su, 2013; Zhou, Zeng, Fan & Di, 2018).

This information is important for the study since the measure allows us to identify the central figures in the network as they may be driving information flow at this early stage of the network. Studying this pattern is deemed a critical first step when examining network activity and be a useful predictor variable for productivity in the present study (Freeman, 2004; Opsahl, Agneessens & Skvoretz, 2010). Degree centrality for undirected networks is formally defined as,

$$k_i = \sum_{j}^{n} x_{ij}$$

where, *i* refers to a single organization and *j* refers to all other organizations. x_{ij} is defined as 1 if node *i* is connected to node *j*, and 0 otherwise. Additionally, *n* refers to the number of organizations in SHRAC (Opsahl et. al., 2010). The calculation of degree centrality quantifies activity for the organizations in the network (Ergün & Usluel, 2016). Organizations with high centrality scores are well connected and can be considered central actors in the collaboration. Degree centrality and density were calculated in UCINET©. Scores would range from 0 (no connections to any other organization) to 22 (connected to all other organizations in the committee).

4.2.2.2. QAP Correlation

Researchers calculated degree centrality scores for all organizations in the network. Subsequently, a statistical analysis strategy was employed where degree centrality scores for each collaboration network were examined in relation to productivity in a QAP correlation (Kwak & Clayton-Matthews, 2002). Correlation variables included degree centrality in all five collaboration domains and productivity outcomes.

We first ran frequency statistics using the Statistical Analysis System (SAS) to understand the aggregate degree centrality scores for the collaboration networks on average, as well as individually for the sharing information, technical assistance, jointly planning, sharing resources, and MOA/contract networks. Then, frequency statistics were calculated for the answers to the two community-focused productivity questions including how often organizations shared information about infant safe sleep to the community and how often organizations provided or donated infant safe sleep resources

to the community. Next we ran multiple QAP correlations in UCINET© to evaluate the association between degree centrality within the collaboration networks and productivity measures related to 1.) sharing information, and 2.) providing or donating resources.

4.3. Results

From the 23-organization network, data was analyzed from the majority of network members (n=13). These organizations represented multiple sectors including government (n=5), healthcare (n=4), nonprofit (n=3), and social services (n=1). On average across all five collaboration domains, most organizations (n=10) received a degree centrality score between 8-15, meaning most organizations were connected to at least one third of all other organizations in the network. When examining centrality across the individual collaboration domains, most organizations are well-connected in the information sharing network, with the majority (n=11) connected to at least 16 other members. The other collaboration domains had less central members with 9 - 11 members reporting low centrality scores for the technical assistance, jointly planning, sharing resources, and MOA/contract networks. Table 1 provides more information on the distribution of centrality scores across collaboration domains, summarized by a gradient centrality index to demonstrate relative centrality (Golbeck, 2013).

Table 4-1: Degree Centrality Score Distribution across Collaboration Domains (n=13)

	Less Central (Score: 1-7)	Moderately Central (Score: 8-15)	Highly Central (Score: 16-22)
Information Sharing	-	15.38% (2 orgs)	84.62% (11 orgs)
Technical Assistance	69.23% (9 orgs)	23.08% (3 orgs)	7.69% (1 org)
Jointly Planning	76.92% (10 orgs)	7.69% (1 org)	15.38% (2 orgs)
Sharing Resources	84.62% (11 orgs)	-	15.38% (2 orgs)
MOA/ Contract	69.23% (9 orgs)	-	30.77% (4 orgs)

When examining measures of productivity overall, data indicates that organizations were fairly productive towards the two community goals in the SleepTight mission. For the first goal question, related to providing information on safe sleep education to the Hampton Roads community over the past 12 months, nearly half of respondents (n=6) reported providing information on a daily or almost daily basis to Hampton Roads families, followed by on a weekly or almost weekly basis (n=4). No respondents reported "never" engaging in this activity over the last 12 months.

The second goal focused on providing or donating resources to programs related to safe infant sleep over the past 12 months. In comparison to the first goal, this activity occurred on a less frequent basis. Approximately one-third of respondents (n=4) reported donating or providing infant safe sleep resources monthly or almost monthly, followed by weekly or almost weekly (n=3). However, nearly one-third also reported having never engaged in this activity (n=3). Table 2 summarizes frequency of productivity measures across all respondents.

Table 4-2: Frequency of Organization Productivity in Past 12 Months (n=13)

Productivity Measure	Never	Once or Twice	Every Few Months	Monthly/Almost Monthly	Weekly/Almost Weekly	Daily/Almost Daily
Providing Target Population with Information on Safe Sleep	-	1 (7.69%)	1 (7.69%)	1 (7.69%)	4 (30.77%)	6 (46.15%)
Providing or Donating Target Population with Safe Sleep Resources	3 (23.08%)	1 (7.69%)	-	4 (30.77%)	3 (23.08%)	2 (15.38%)

Tables 3 shows results from the QAP correlation between degree centrality in the five collaboration domains and the two measures of productivity. Across all collaboration domains, there were no statistically significant correlations between degree centrality and productivity towards 1) providing safe sleep information to the target population, and 2) providing or donating safe sleep However, statistically significant associations emerged between information sharing and MOA/contract degree centrality (r=0.424), as well as between the two productivity measures (r=0.630).

Table 4-3: QAP Correlations between Degree Centrality Scores and Productivity Variables

	IS DC	TA DC	JP DC	SR DC	MOA DC	SS Info to TP	SS Resources to TP
IS DC	-						
TA DC	0.330	-					
JP DC	-0.313	-0.230	-				
SR DC	0.308	0.128	0.088	-			
MOA DC	0.424*	-0.245	0.270	0.090	-		
SS Info to TP	-0.231	0.245	0.028	-0.303	0.285	-	
SS Resources to TP	0.288	0.286	0.059	-0.007	0.339	0.630*	-

Note. n=13. IS DC=information sharing degree centrality; TA DC= technical assistance degree centrality; JP DC= jointly planning degree centrality; SR DC= sharing resources degree centrality; MOA DC= memoranda of agreement/contract degree centrality; SS Info to TP= Providing safe sleep information to target population; SS Resources to TP= Providing or donating safe sleep resources to target population; *p<0.05

4.4. Discussion

Results from the present study indicate that degree centrality in relation to collaboration is not a significant predictor of productivity in this health network. This

finding sheds light on the nature of what makes for productivity in an interorganizational partnership context. Organizations with high centrality can be considered central actors in the collaboration (Borgatti, 2005). However, in regards to productivity toward the mission, this role of central actor in collaboration activities may not be a significant factor towards individual productivity to the overall mission.

Though the association between degree centrality and productivity may not be significant in this analysis, overall, organizations in the network are independently productive towards the mission. In regards to providing information on infant safe sleep to the community, the network members engaged in this activity frequently within the last 12 months. This finding may be linked to the high connectedness of all organizations in the information sharing network. As this was the most connected collaboration network, it may indicate that sharing information is prioritized not only within the network, but also by individual members to the community. Given the positive correlation between centrality within the intra-network MOA and information sharing collaboration networks, formal agreements or contracts could continue to drive members to conduct this activity over time.

In addition, QAP correlation results found that the two productivity measures were positively associated, indicating that these two community goals may be mutually reinforcing, and could drive overall productivity over time. When diving deeper into the two productivity measures, network members were slightly less engaged in the second network goal of donating or providing resources to the community. This activity is decidedly costlier, both financially and by opportunity, than the activity of sharing

information (Knowles & Servátka, 2015), which may be the reason for relatively lower frequency of engagement. Additionally, survey results show that members were likely either not to engage in this activity at all, or to do so more frequently, such as monthly, weekly, or even daily. This finding indicates that this activity, if it were to occur, may take place in a more scheduled manner as compared to information sharing, which can likely occur on an ad hoc basis.

Taken together, these findings support existing network research. One such network study, for example, concludes that collaboration intensity is not necessarily uniform across various disciplines, and thus productivity may be more stimulated by collaboration in some contexts, such as collaboration with organizations in different domains or line of work (Abramo, D'Angelo & Di Costa, 2009). Additionally, centrality may seem more appropriate as an indicator of an organization's role of a frequent or quality collaborator with others in the network, rather than a leader in productivity towards the mission (Kwait, Valente & Celentano, 2001). Given that the majority of the organizations in this study's network work in the same geographic region and include many organizations from the same or similar sector, those that are more central in collaboration contexts may not be as meaningful for organizational productivity.

On the other hand, findings deviate slightly from the centrality-productivity literature from the early 20th century. In a study cumulating centrality-productivity literature from 1948-1979, evidence indicated that that centrality and productivity were weakly connected (Hummon, Doreian & Freeman, 1990). This evidence was supported in studies that examined centrality as a moderator of performance (Ahuja, Galletta &

Carley, 2003; Ferriani, Cattani, & Baden-Fuller, 2009). Some explanations for the results in the current study may be due to different aspects of the network in the study. Previous literature does not focus on public health networks or organizational relationships towards health intervention outcomes. The specific nature of the network may indicate why degree centrality may not be indicative of organizational productivity as in other studies, and it can be a consideration to explore more deeply in future studies.

A few limitations in this study include overall sample size, which could have affected the ability to produce significant results. Additionally, due to the network focus of the study and data collection tool, demographic data on the organizations were not collected or included in the present analysis. Future research should consider acquiring this information, such as organization size and age, to determine if demographic covariates may have an impact on productivity.

In relation to study design, while a QAP correlation was an appropriate statistical model for the research question, there are limitations given the results. For instance, as none of the correlations were statistically significant, we were not only unable to determine whether degree centrality was associated with productivity, but also understand how it might be associated (e.g. if central figures in one collaboration domain may be more likely to be productive compared to central figures in another collaboration domain, etc.). This issue may not occur if the sample size were larger, where we may see significant findings.

4.5. Conclusion

Despite these limitations this study helps address a current knowledge gap related to interorganizational networks and productivity in health interventions. Previous studies have examined this question from an individual context. This study presents information on how productivity can be examined in an organizational context, and it provides a refresher on the literature examining associations between centrality and productivity from a different perspective. This information is useful from a health network program planning perspective when examining patterns of collaboration and productivity towards a collective mission, a trend that will continue to persist within the complex field of public health.

5. CONCLUSIONS

This research provides a unique examination of Collective Impact (CI) network in practice. In the field of community health, the use of collective action through public health networks have helped alleviate health disparities for many years. CI has emerged in recent years as a promising approach to addressing complex, community-level issues using this collaborative approach as a new structured framework (Kania & Kramer, 2011). Given its recent entry to the field, CI research is needed to explore the collaborative mechanisms of a network that makes up a CI initiative, as well as a deeper examination of collaboration in relation to productivity.

Study findings help address this gap by providing an examination of infant safe sleep CI network from the standpoint of collaboration. Using an interorganizational network (ION) analysis methodology proved as a useful methodology to understand the functioning of organizational members towards a mission. In addition, by means of employing an ION analysis, organizational members of CI serve as the unit of analysis and this information be helpful to local leaders to understand how organizations may play different roles in various collaboration contexts. We are also able to explore how the five elements of CI may exist or be prioritized differently within practical application. For example, a backbone organization might not a central figure in the element of continuous communication across various collaboration domains. This context can be explored deeper in other contexts to determine what is valued by different CI's given member or the target population needs, among other factors. Studying this specific CI, Sleep Tight Hampton Roads, is meaningful due to its recent establishment

and opportunities to take research insights to the CI as well as similar initiatives that may exist or form given the importance of addressing infant safe sleep habits in specific communities.

The second study builds upon the exploratory results presented in the CI examination. Specifically, ION measures were reviewed as a change over time, which is helpful as passage of time is necessary to ensure a diffusion of information and resources among collaborators in a network (Mahajan, 2010; Meade & Islam, 2006). This data is meaningful in that it explores how aspects of an infant health network changes over time in relation to a predefined network attributes, as well as network transformation to include new ties. This information is again useful from a planning perspective for such networks, CI or not, particularly in the field of infant health, where networks often emerge and exist to tackle the issues that feed into this complex health challenge at the community.

Organizations in such networks continue to play different roles in various collaboration contexts. Additionally, given the passage of time as is described in the Diffusion of Innovation Theory for networks, it is understood that shifts will occur in not only the role of organizations, but also what types of communication channels persist over the passage of time. These changes include variations in members who may play a central role in collaboration at different timepoints, and how a network transforms through these aspects from a network structure perspective. We are also given insight on the perspective of network transformation through the lens of collaboration. Within a given health network, certain collaboration domains may be more important and

maintained over time. However, with non-network members, collaboration could be limited to more basic forms of collaboration, such as information sharing, given there are no pre-defined expectations of collaboration.

Lastly, the final study explores how productivity, in the realm of frequency of efforts over time towards the CI mission, can be influenced by network attributes. The present study indicates that degree centrality may not be correlated with productivity, a deviation from the social network analysis literature from the early 20th century. Other takeaways include what types of productivity efforts may be more easily achievable for organizational members of a public health network, such as those that may require less effort, as well as useful information on overall network productivity, which can be helpful for leaders of the initiative to consider and utilize for continued program development and implementation.

Future research is still needed in the area CI initiative collaboration and productivity. Specifically, closer examinations of CI and how network attributes may or may not support various elements of the CI framework would be helpful for CI implementers, decision makers, and other relevant stakeholders. Additionally, examining CI network change and transformation over time would support this endeavor. It is important to understand how theory acts in practice in order to refine theory meaning over time. Finally, increased attention in the field at large is encouraged to understand and disseminate information about productivity in the field. Given the transient nature of funding, or lack thereof, for public health initiatives, it remains pertinent to incorporate impact-type analyses such as productivity into future research.

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APPENDIX A

INTERORGANIZATIONAL NETWORK (ION) SURVEY TOOL

The purpose of this Interorganizational Network Survey is to examine how organizations involved with the Sleep Tight Hampton Roads Advisory Committee in Minus 9 to 5 collaborate to create a community culture the embraces infant safe sleep through collaboration, partnership, and action, ensuring that all infants in Hampton Roads sleep safely.

As a representative of your organization, you are being asked to participate in this survey because your organization is a vital part of the Sleep Tight Hampton Roads Advisory Committee.

To proceed to the survey, click on proceed and view information sheet.

☐ Proceed and view information sheet (1)

Q3 **Instructions:**

This survey will ask you about your organization's work in infant safe sleep and relationships with others involved with Minus 9 to 5's Sleep Tight Hampton Roads Advisory Committee.

The first set of questions simply asks about your organization and your organization's work in infant safe sleep. The next set of questions ask how your organization has worked with others involved with the Sleep Tight Hampton Roads Advisory Committee. Please answer with respect to activities occurring throughout your ENTIRE organization, in addition to those involving you and your individual department.

When you reach your name in the second set of questions, please indicate it is your organization by clicking the "This is my organization" option.

Q4 Please indicate which organization you represent:

- ○ Bon Secours DePaul Medical Center (15)
- ○ Bon Secours Maryview Medical Center (20)
- ○ Champions for Children (19)
- ○ Chesapeake Department of Health (3)
- ○ Chesapeake Department of Social Services (1)
- ○ Chesapeake Regional Hospital (8)
- ○ Children's Hospital of the King's Daughter (18)
- ○ CHIP of South Hampton Roads (7)
- ○ Eastern Region Child Fatality Review Team (16)
- ○ EVMS, Pediatric Department (5)
- ○ EVMS/Children's Hospital of the King's Daughter (13)
- ○ EVMS/Consortium for Infant and Child Health (12)
- ○ Naval Medical Center Portsmouth (43)
- ○ Norfolk Department of Social Services (14)
- ○ Norfolk Public Health (10)
- ○ Portsmouth Baby Care (6)
- ○ Portsmouth Department of Social Services (2)

- ○ Sentara Norfolk General (4)
- ○ Sentara Princess Anne (11)
- ○ Suffolk Department of Public Health (17)
- ○ Suffolk Social Services (9)
- ○ Virginia Beach Human Services (39)
- ○ Virginia Department of Health (40)

Q5 What sector does your organization represent?

- ○ Education (1)
- ○ Non profit (2)
- ○ Government (3)
- ○ Healthcare (4)
- ○ Business (5)
- ○ Community organization (6)
- ○ Media (7)
- ○ Social services (9)

Q6 The following questions probe on your organization's commitment and work in infant safe sleep. Please answer these questions **in respect to your organization**.

Q7 Please rank your overall agreement with the following statements.

	Strongly disagree (25)	Disagree (26)	Somewhat disagree (28)	Somewhat agree (29)	Agree (30)	Strongly Agree (31)
I find that my organization’s mission/vision/values are similar to Minus 9 to 5's mission/vision/values. (Minus 9 to 5 Vision: "Each family in Hampton Roads will be equipped and supported to raise children who are healthy, thriving, and ready to learn.") (11)	○	○	○	○	○	○
I find that my organization is achieving its intended results related to infant safe sleep in the Hampton Roads community. (12)	○	○	○	○	○	○

Q8 Please indicate how often your organization conducted the following activities, if at all, over the last 12 months.

	Never (1)	Once or twice (2)	Every few months (3)	Monthly/almost monthly (4)	Weekly/almost weekly (7)	Daily/almost daily (8)
In the LAST 12 MONTHS, how often did your organization work directly with the community/target population (Hampton Roads newborns and/or mothers) on activities related to infant safe sleep? (3)	○	○	○	○	○	○
In the LAST 12 MONTHS, how often did your organization provide information on safe sleep education to the Hampton Roads community? (4)	○	○	○	○	○	○

In the LAST 12 MONTHS, how often did your organization provide or donate resources to programs related to safe infant sleep? (5)	○	○	○	○	○	○

Q9 **How has the frequency of the following activities changed in your organization <u>over the last 12 months</u>?**

	Decreased (1)	Stayed the same (2)	Increased (3)
Work directly with the community/target population (Hampton Roads newborns and/or mothers) on activities related to infant safe sleep (3)	○	○	○
Provide information on safe sleep education to the Hampton Roads community (4)	○	○	○
Provide or donate resources (e.g., portable cribs) to programs related to safe infant sleep (5)	○	○	○

Q10 The following questions probe on your organization's collaboration in the Sleep Tight Hampton Roads Advisory Committee. When you reach your organization's name, please indicate it is your organization by clicking the “This is my organization” option.

Q11 **SHARING INFORMATION**
Sharing information *refers to receiving or providing data, updates on related programs or services, educational materials, newsletters and/or other types of information related* ***specifically to infant safe sleep in Hampton Roads.***

How often in the LAST 12 MONTHS did your organization EXCHANGE or SHARE INFORMATION with the following organizations regarding infant safe sleep for Hampton Roads residents?

	Once or twice (1)	Every few months (2)	Monthly/almost monthly (3)	Weekly/almost weekly (4)	Daily/almost daily (5)	Never (0)	This is my organization (6)
Bon Secours DePaul Medical Center (1)	○	○	○	○	○	○	○
Bon Secours Maryview Medical Center (2)	○	○	○	○	○	○	○
Champions for Children (3)	○	○	○	○	○	○	○
Chesapeake Department of Health (5)	○	○	○	○	○	○	○
Chesapeake Department of Social Services (4)	○	○	○	○	○	○	○
Chesapeake Regional Hospital (6)	○	○	○	○	○	○	○
Children's Hospital of the King's Daughter (7)	○	○	○	○	○	○	○
CHIP of South Hampton Roads (8)	○	○	○	○	○	○	○

Eastern Region Child Fatality Review Team (9)	○	○	○	○	○	○	○
EVMS, Pediatric Department (10)	○	○	○	○	○	○	○
EVMS/Children's Hospital of the King's Daughter (11)	○	○	○	○	○	○	○
EVMS/Consortium for Infant and Child Health (12)	○	○	○	○	○	○	○
Naval Medical Center Portsmouth (14)	○	○	○	○	○	○	○
Norfolk Department of Social Services (15)	○	○	○	○	○	○	○
Norfolk Public Health (16)	○	○	○	○	○	○	○
Portsmouth Baby Care (17)	○	○	○	○	○	○	○
Portsmouth Department of Social Services (18)	○	○	○	○	○	○	○

Sentara Norfolk General (19)	○	○	○	○	○	○	○
Sentara Princess Anne (21)	○	○	○	○	○	○	○
Suffolk Department of Public Health (22)	○	○	○	○	○	○	○
Suffolk Social Services (23)	○	○	○	○	○	○	○
Virginia Beach Human Services (24)	○	○	○	○	○	○	○
Virginia Department of Health (25)	○	○	○	○	○	○	○

Q12 If you did share information, what type of information did you share with these organizations (i.e. campaign materials, best practices, etc.)?

Please specify what information was shared with which organization (e.g. "*shared SIDS prevention social media messages with St. Joseph's Hospital*").

_____

Q13 **TECHNICAL ASSISTANCE** Technical assistance, a form of information sharing, refers to receiving or providing general or program-specific support that improves understanding, implementation, and organizational capacity related specifically to infant safe sleep in Hampton Roads.

How often in the LAST 12 MONTHS did your organization RECEIVE TECHNICAL ASSISTANCE (in the form of expert recommendations, skills training, etc.) from the following organizations regarding infant safe sleep for Hampton Roads residents?

	Once or twice (1)	Every few months (2)	Monthly/almost monthly (3)	Weekly/almost weekly (4)	Daily/almost daily (5)	Never (0)	This is my organization (6)
Bon Secours DePaul Medical Center (x1)	○	○	○	○	○	○	○
Bon Secours Maryview Medical Center (x2)	○	○	○	○	○	○	○
Champions for Children (x3)	○	○	○	○	○	○	○
Chesapeake Department of Health (x5)	○	○	○	○	○	○	○
Chesapeake Department of Social Services (x4)	○	○	○	○	○	○	○
Chesapeake Regional Hospital (x6)	○	○	○	○	○	○	○
Children's Hospital of the King's Daughter (x7)	○	○	○	○	○	○	○
CHIP of South Hampton Roads (x8)	○	○	○	○	○	○	○

Eastern Region Child Fatality Review Team (x9)	○	○	○	○	○	○	○
EVMS, Pediatric Department (x10)	○	○	○	○	○	○	○
EVMS/Childr en's Hospital of the King's Daughter (x11)	○	○	○	○	○	○	○
EVMS/Conso rtium for Infant and Child Health (x12)	○	○	○	○	○	○	○
Naval Medical Center Portsmouth (x14)	○	○	○	○	○	○	○
Norfolk Department of Social Services (x15)	○	○	○	○	○	○	○
Norfolk Public Health (x16)	○	○	○	○	○	○	○
Portsmouth Baby Care (x17)	○	○	○	○	○	○	○

Portsmouth Department of Social Services (x18)	○	○	○	○	○	○	○
Sentara Norfolk General (x19)	○	○	○	○	○	○	○
Sentara Princess Anne (x21)	○	○	○	○	○	○	○
Suffolk Department of Public Health (x22)	○	○	○	○	○	○	○
Suffolk Social Services (x23)	○	○	○	○	○	○	○
Virginia Beach Human Services (x24)	○	○	○	○	○	○	○
Virginia Department of Health (x25)	○	○	○	○	○	○	○

Q14 If you did receive technical assistance, what type of information did you receive from these organizations (i.e. training, guidelines, webinar, etc.)?

Please specify what technical assistance was received from which organization (e.g. "*attended webinar on SIDS prevention from St. Joseph's Hospital*").

_____

Q15 **JOINTLY PLANNING, COORDINATING OR CONDUCTING ACTIVITIES, TRAINING OR EVENTS** ***Jointly planning, coordinating or conducting an activity, training, event or program*** refers to things like aligning infant

safe sleep education and messages across the Hampton Roads region, planning a health education workshop with families and their providers, or developing a social media message campaign.

In the LAST 12 MONTHS, how often did your organization JOINTLY PLAN, COORDINATE, OR IMPLEMENT AN ACTIVITY, TRAINING, EVENT, or PROGRAM with the following organizations regarding infant safe sleep education and messages across the Hampton Roads region?

	Once or twice (1)	Every few months (2)	Monthly/almost monthly (3)	Weekly/almost weekly (4)	Daily/almost daily (5)	Never (0)	This is my organization (6)
Bon Secours DePaul Medical Center (x1)	○	○	○	○	○	○	○
Bon Secours Maryview Medical Center (x2)	○	○	○	○	○	○	○
Champions for Children (x3)	○	○	○	○	○	○	○
Chesapeake Department of Health (x5)	○	○	○	○	○	○	○
Chesapeake Department of Social Services (x4)	○	○	○	○	○	○	○
Chesapeake Regional Hospital (x6)	○	○	○	○	○	○	○
Children's Hospital of the King's Daughter (x7)	○	○	○	○	○	○	○
CHIP of South Hampton Roads (x8)	○	○	○	○	○	○	○

Eastern Region Child Fatality Review Team (x9)	○	○	○	○	○	○	○
EVMS, Pediatric Department (x10)	○	○	○	○	○	○	○
EVMS/Childr en's Hospital of the King's Daughter (x11)	○	○	○	○	○	○	○
EVMS/Conso rtium for Infant and Child Health (x12)	○	○	○	○	○	○	○
Naval Medical Center Portsmouth (x14)	○	○	○	○	○	○	○
Norfolk Department of Social Services (x15)	○	○	○	○	○	○	○
Norfolk Public Health (x16)	○	○	○	○	○	○	○
Portsmouth Baby Care (x17)	○	○	○	○	○	○	○

Portsmouth Department of Social Services (x18)	○	○	○	○	○	○	○
Sentara Norfolk General (x19)	○	○	○	○	○	○	○
Sentara Princess Anne (x21)	○	○	○	○	○	○	○
Suffolk Department of Public Health (x22)	○	○	○	○	○	○	○
Suffolk Social Services (x23)	○	○	○	○	○	○	○
Virginia Beach Human Services (x24)	○	○	○	○	○	○	○
Virginia Department of Health (x25)	○	○	○	○	○	○	○

Q16 If you did jointly plan, coordinate, or implement an activity, training, event, or program, what was the type of activity (i.e. fundraiser, health fair, education session, etc.)?

Please specify what activity was conducted with which organization(s) (e.g. "*planned health fair with St. Joseph's Hospital and St. Mary's Clinic*).

Q17 **SHARING TANGIBLE RESOURCES**

Sharing tangible resources refers to sharing or exchanging resources such as staff, space, equipment, or funds. This may or may not involve formal working arrangements between organizations, like contracts, subcontracts, resolutions or memorandum of agreement.

In the LAST 12 MONTHS, did your organization SHARE OR EXCHANGE TANGIBLE RESOURCES with the following organizations regarding infant safe sleep for Hampton Roads residents?

	Yes (1)	No (0)	This is my organization (6)
Bon Secours DePaul Medical Center (x1)	○	○	○
Bon Secours Maryview Medical Center (x2)	○	○	○
Champions for Children (x3)	○	○	○
Chesapeake Department of Health (x5)	○	○	○
Chesapeake Department of Social Services (x4)	○	○	○
Chesapeake Regional Hospital (x6)	○	○	○
Children's Hospital of the King's Daughter (x7)	○	○	○
CHIP of South Hampton Roads (x8)	○	○	○
Eastern Region Child Fatality Review Team (x9)	○	○	○
EVMS, Pediatric Department (x10)	○	○	○
EVMS/Children's Hospital of the King's Daughter (x11)	○	○	○

EVMS/Consortium for Infant and Child Health (x12)	○	○	○
Naval Medical Center Portsmouth (x14)	○	○	○
Norfolk Department of Social Services (x15)	○	○	○
Norfolk Public Health (x16)	○	○	○
Portsmouth Baby Care (x17)	○	○	○
Portsmouth Department of Social Services (x18)	○	○	○
Sentara Norfolk General (x19)	○	○	○
Sentara Princess Anne (x21)	○	○	○
Suffolk Department of Public Health (x22)	○	○	○
Suffolk Social Services (x23)	○	○	○
Virginia Beach Human Services (x24)	○	○	○
Virginia Department of Health (x25)	○	○	○

Q18 If yes, what was it you shared?

Please specify what was shared with which organization (e.g. "*provided volunteers for St. Joseph's Hospital baby fair*").

_____

Q19 **Did your organization have a formal memorandum of agreement or contract with the following organizations regarding the shared resource?**

	Yes (1)	No (0)	This is my organization (6)
Bon Secours DePaul Medical Center (x1)	○	○	○
Bon Secours Maryview Medical Center (x2)	○	○	○
Champions for Children (x3)	○	○	○
Chesapeake Department of Health (x5)	○	○	○
Chesapeake Department of Social Services (x4)	○	○	○
Chesapeake Regional Hospital (x6)	○	○	○
Children's Hospital of the King's Daughter (x7)	○	○	○
CHIP of South Hampton Roads (x8)	○	○	○
Eastern Region Child Fatality Review Team (x9)	○	○	○
EVMS, Pediatric Department (x10)	○	○	○
EVMS/Children's Hospital of the King's Daughter (x11)	○	○	○
EVMS/Consortium for Infant and Child Health (x12)	○	○	○

Naval Medical Center Portsmouth (x14)	○	○	○
Norfolk Department of Social Services (x15)	○	○	○
Norfolk Public Health (x16)	○	○	○
Portsmouth Baby Care (x17)	○	○	○
Portsmouth Department of Social Services (x18)	○	○	○
Sentara Norfolk General (x19)	○	○	○
Sentara Princess Anne (x21)	○	○	○
Suffolk Department of Public Health (x22)	○	○	○
Suffolk Social Services (x23)	○	○	○
Virginia Beach Human Services (x24)	○	○	○
Virginia Department of Health (x25)	○	○	○

Q20 **In addition to the organizations previously listed, do you work closely with any other organizations on activities related to infant safe sleep?**

○ Yes (1)

○ No (2)

Q21 **Please list up to five additional organizations that you work with closely on activities related to infant safe sleep.**

- ○ Organization 1 (1) _____
- ○ Organization 2 (2) _____
- ○ Organization 3 (3) _____
- ○ Organization 4 (4) _____
- ○ Organization 5 (5) _____

Q22 **When thinking about your organization's work related to infant safe sleep, over the LAST 12 MONTHS, did your organization participate in any of the following activities with the organizations listed: (check all that apply)**

	Exchange or share information (1)	Jointly plan, coordinate, implement an activity (2)	Share or exchange tangible resources (3)	Have a formal memorandum of agreement or contract (4)
Organization 1 (x1)	☐	☐	☐	☐
Organization 2 (x2)	☐	☐	☐	☐
Organization 3 (x3)	☐	☐	☐	☐
Organization 4 (x4)	☐	☐	☐	☐
Organization 5 (x5)	☐	☐	☐	☐

Q23 **Thank you for taking the time to complete this survey! If you have any additional comments related to Minus 9 to 5's Sleep Tight Hampton Roads Advisory Committee, please write your thoughts below.**