

Examining Explanatory Inputs and Community System Change Intensity

By

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Abstract

This investigation into behavioral science of community health systems improvement is the result of a concern about the observed discrepancy between what is planned and what is actually accomplished in community. Differences in methods of development and implementation for population-level health improvement programs are affected by collaborative efforts to modify and improve systems. The variability in outcomes may be attributed to the unfolding development of structure of a community coalition or partnership and community system changes completed during project implementation efforts over time. Comparing community system change intensity to implementation efforts across sites can demonstrate effectiveness through replication and predicting the influence of interventions.

Supported by Bristol-Myers Squibb Foundation's Together on Diabetes Initiative, three community-based projects were selected for analyses. Development activities, services provided, and resources generated (i.e., the actions which prepare or enable a collaborative to address goals and objectives, the delivery of information, training, or other valued goods and activities, and the acquisition of funding or resources through grants, donations or gifts in-kind, respectively) served as independent variables. The community system changes – new or modified programs, policies or practices in the community, organization, or system – partnerships completed served as the dependent variable.

A multiple case study was applied to show replications across various contexts. Linear regression analyses found significant associations between inputs and system changes for two sites. Projected impact of system changes was determined using established intensity scoring procedures. Data suggests linkages between inputs influenced implemented system changes and intensity values.

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Introduction

Health Inequities

Produced by societal inequalities, the World Health Organization determines health inequities as “avoidable.” Health inequities are systematic inequalities in health status between groups of people within a population. A nation’s social and economic systems shape the conditions and determinants of their population’s health (WHO, 2017).

Social and economic opportunities available to a population can be identified within a community, thus producing evidence for where inequalities exist. Factors such as access to care, employment, socioeconomic status, and education are examples of social determinants of health. The physical environmental conditions (e.g., housing designs, exposure to toxins, green spaces) additionally influence the quality of life and health outcomes communities experience (DHHS, 2018).

Health inequities affects the productivity and economic costs associated with society. The United States spends 50 percent more in health care than other countries yet reducing health disparities can reduce substantial costs for the nation (NIH, 2016). LaVeist, Gaskin, and Richard estimate the economic cost of health inequities to be \$300 billion annually in direct, indirect, and premature death costs (2011). Understanding and measuring the individual factors, personal behaviors, and environmental conditions that promote health improvement is imperative to investments in public health (IOM, 2003).

Community health equity research and intervention is a priority for funding organizations such as the Center for Disease Control and Prevention, the National Institutes of Health, and the Robert Wood Johnson Foundation (CDC, 2017; NIH, 2018; RWJF, 2018). For example, the Racial and Ethnic Approaches to Community Health (REACH) program fund awarded \$23.2

million to culturally appropriate interventions in 2017. The purpose of these funding efforts was to tailor comprehensive community-based approaches to address risk factors in school, workplace, health care, and community settings (CDC, 2017; DHHS, 2018).

Improving Community Health

Community interventions designed to improve community systems (i.e., health programs, policies and practices) are the result of attempts to restructure disproportionate allocation of health efforts and limited effectiveness of government programs. Communities can improve population health outcomes through organized collaborative action targeting social determinants of health and environmental conditions (IOM, 2003). Comprehensive community interventions target multiple levels of the socioecological model to influence individual health behaviors (Ritchie et al., 2015).

Developing a comprehensive intervention is a complex process and requires continuous engagement of both diverse community partners and groups throughout the development of multiple intervention strategies and the implementation process (Stokosl et al., 1996). The Social Ecological Model is a systems model demonstrating how an individual's behavior is affected by the multiple levels of influence (i.e., social and economic systems). Community health promotion interventions address the knowledge that appropriate behaviors are influenced by intrapersonal factors, interpersonal processes, primary groups, institutional factors, community factors, and public policy (McLeroy, Bibeau, Steckler, and Glanz, 1988). The implementation of community-based programs and policies should reflect strategies for change across multiple levels and multiple target behaviors. Health improvement evaluation allows community groups receive feedback to adjust initiatives and increase the likelihood of attaining target outcomes (Community Tool Box, 2017).

Community Initiative Evaluation

Community initiative evaluation produces evidence for progress, best practices, lessons learned, and achieving outcomes. A model for community evaluation suggests coupling technical assistance throughout the process to support community system change (see Figure 1). The five components within the Center for Community Health and Development evaluation model support participatory engagement as equal partners in documenting and measuring progress. These components are iterative and continuous processes occurring throughout the existence of the initiative.

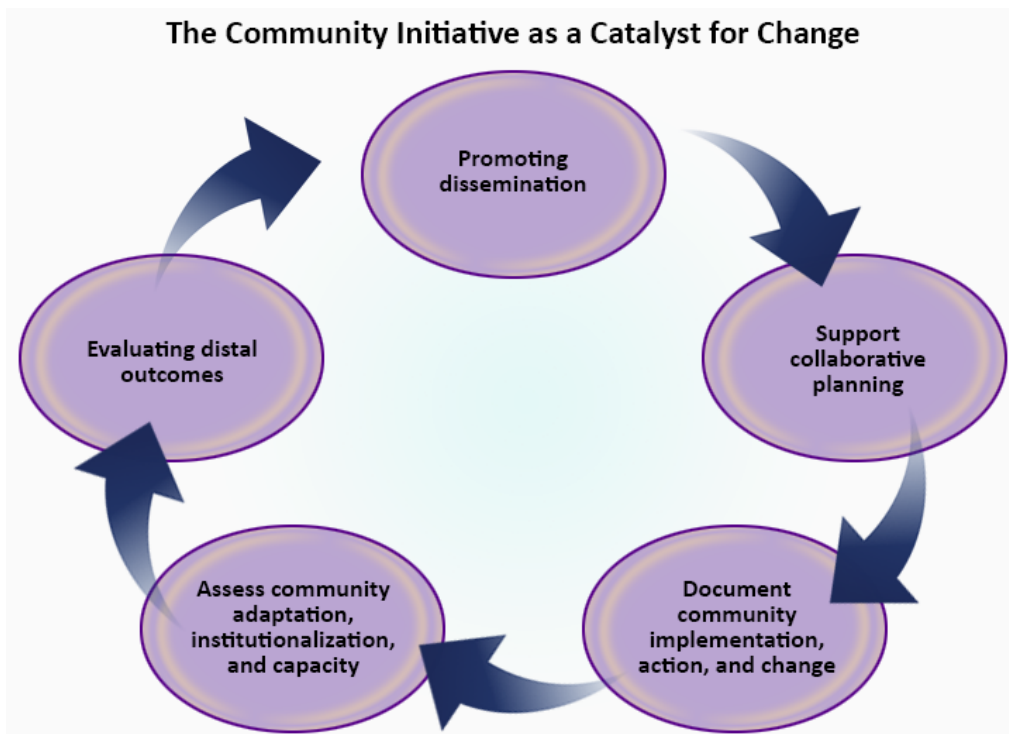


Figure 1. University of Kansas Center for Community Health and Development Evaluation Model

Collaborative planning is a component requiring partnerships within a community to conduct advocacy, organization, assess resources, and set agendas to address local health needs. Documenting community efforts based on the aforementioned process allows members of an

initiative to record implementation activities and community system changes. Assessing capacity, institutionalization, and adaptation is key to improving effective implementation and determining sustainability. Distal outcomes are analyzed using mixed methods approaches to community-level outcomes. Acquiring both qualitative and quantitative data informs initiatives of patterns in system improvement which indicate long-term health outcomes. Dissemination of effective intervention conditions, as determined by analysis and interpretation, provides evidence by which funders and other communities use to make health improvement investment and resource decisions (Community Tool Box, 2017). This is an important distinction because every community system change and intervention will not have the same effect across different communities.

Measuring Progress

Within the last five years, few studies attempted to measure the intensity of community system change efforts by local collaborative partnerships funded to address health disparities and improve community health (Ritchie et al., 2015; Frongillo et al., 2015). This is due to a lack of data available to local agencies and the expense of continuous monitoring and evaluation (Shah, Russo, Earl, & Kuo, 2014). Common data measures utilized to assess comprehensive community intervention progress involves surveys and assessments, typically on behaviors of individuals, to produce statistical analyses models (Ritchie et al., Frongillo et al., 2015). To address the limitations of measurement consistency and reliability, an intensity score procedure was developed by technical assistance to systematically assess the progress of a community-based initiative in implementing community system changes (Collie-Akers, Fawcett, & Schultz, 2013).

Collie-Akers and colleagues (2013) developed a procedure in which dimensions of duration, reach, and strategy – common to all community system changes – were computed to produce a relative strength value. Each community system change was documented in an online evaluation system, systematically coded by activity based on operational definitions within a shared codebook and characterized by dimensions to communicate contribution. This study found the intensity method communicated the number and extent of community system changes increased each year.

Using similar systematic coding and characterization procedures, The Healthy Communities Study replicated the aforementioned intensity score procedure to analyze differences in health outcome measures (i.e. BMI, waist circumference) across health initiatives. The study included 10 years of 130 communities' data to demonstrate relationships between community system change and predictive health outcomes (Arteaga et al., 2015; Fawcett, Collie-Akers, Schultz, & Kelley, 2015). This study found neither BMI nor waist circumference outcomes were associated with the intensity score, although the outcomes occurred in the theorized direction.

An advantage provided by community system change intensity scoring is the communication of collaborative progress toward health equity. Additionally, intensity scores examine and compare strategies, reach, and duration features of community system changes systematically and reliably (Collie-Akers, Fawcett, & Schultz, 2013). One study found a significant relationship between standardized intensity index scores and percent reduction in risky behavior (Anderson-Carpenter, 2014). The measure is useful for assessing individual community system changes and community level scores. Furthermore, the intensity score generalizes a measure of relative strength of community system changes across initiatives with

differing goals under natural conditions (Fawcett, Collie-Akers, Schultz, & Kelley, 2015; Collie-Akers, Fawcett, & Schultz, 2013).

Limitations of measuring progress using a novel intensity score procedure stem from limited research. Testing for the validity of the formula for intensity is necessary due to limited replication in the peer reviewed literature. In addition, individual outcomes have not demonstrated a functional relationship to the exposure to a number of community system changes. Common variables in health improvement initiative efforts have not been assessed in relation to intensity (Fawcett, Collie-Akers, Schultz, & Kelley 2015). Lack of research in implementing the intensity score procedure emphasizes the need for repeated measurement (Collie-Akers, Fawcett, & Schultz, 2013).

Present Study

The aims of this study are to examine the relationship between initiative improvement efforts and intensity of community system changes. Variables of interest are operationally defined inputs and community system changes and resulting community system change intensity scores. Inputs include the development activities, services provided, and resources generated by a community health improvement initiative. These inputs are features of interventions employed to improve health outcomes. Community system changes are the implementation of new or modified programs, practices, or policies by the initiative in support of target goals. The intensity is the summation of reach, duration, and behavior change strategies as described in previous research (Collie-Akers, Fawcett, & Schultz, 2013).

This study will address simple interactions between initiative efforts and community system change intensity among community health improvement coalitions and partnerships. By analyzing the developmental events, resources, and services a collaborative engages to achieve

target health outcomes, this study will look at the relationship between the allocation of efforts and intensity. In this manner, the present study will add to existing public health literature by examining the implementation activities that may relate to or strengthen measures of progress.

The purpose of this study is to examine relationships between inputs on community system change intensity across community health improvement initiatives. Few research studies have examined intensity as a measure of relative strength of on health outcomes, and the literature lacks examination of relationships between collaborative activities for change and resulting intensity. This study is the first to analyze and interpret initiative documented input activities in relation to resulting community system change intensity across health improvement sites. This study examines relationships between inputs implemented by community health improvement initiatives and replicates the procedures for community system change intensity.

Method

Background and Context

Determinants of health influence the outcomes for specific populations and generate disparities in outcomes such as infections, injuries, chronic conditions, and death. In the United States, Type 2 diabetes mellitus is the 7th leading cause of death. Minority groups represent 25 percent of the 29.1 million people affected by Type 2 diabetes (DHHS, 2018). In 2012, approximately \$245 billion in costs was associated with type 2 diabetes. With increasing trends in prevalence, addressing community health inequities and emerging health issues for high-risk populations involves changing community systems (CDC, 2017).

The Bristol-Myers Squibb Foundation (BMS) supported community-, regional-, and national-level *Together on Diabetes (ToD)* projects to improve outcomes for patients with type 2 diabetes. Consistent with the foundation's mission for health equity, focal points for funding by

the BMS *Together on Diabetes* initiative included: (a) patient self-management and navigation; (b) integrated community supportive services and broad-based mobilization; (c) innovation fund to develop and test implementation approaches and measure diabetes control efforts. Between the years 2010 and 2018, BMFS funded twenty-five projects in 28 states and the District of Columbia. Each partnering grantee provided process data and measures reflecting intervention-specific actions toward improvement of health outcomes for disproportionately affected populations. This study provides an analysis of grantee sites from the original funded project.

The University of Kansas Center for Community Health and Development served as national evaluators for the coordination of data collection and analysis of ToD project accomplishments, performance, and impacts. Community-level data recorded by grantees demonstrates empirical case measures, as shown in Figure 2, by which assessment of processes and outcomes is facilitated by local partnerships (Francisco et al., 1993).

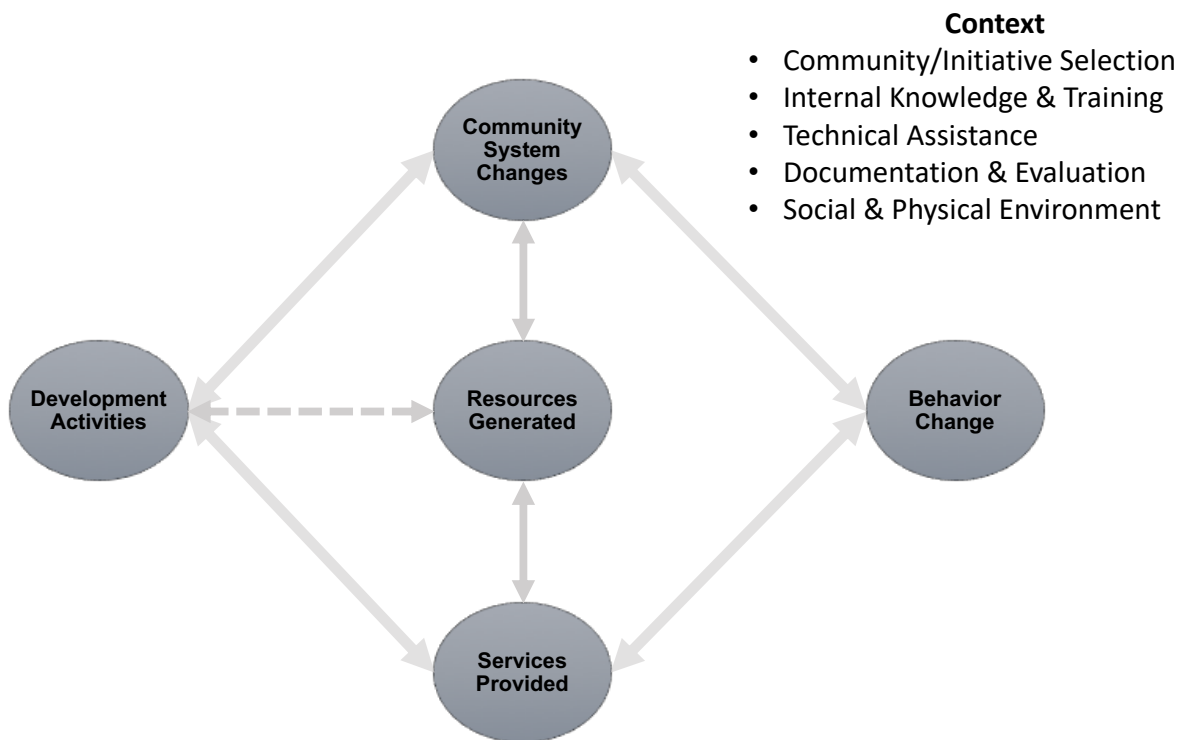


Figure 2. Bristol Meyers-Squibb Foundation (BMS) Together on Diabetes Theory for Change

The theory for change in Figure 2 was developed by conceptualizing project capacity to using behavior change processes in implementation. Logic models which were developed in collaboration with each site, data within the online Community Check Box Evaluation System (CCB), grantee reports, and community indicators were incorporated in the development of this model.

These projects refer to community system changes as “intentional processes designed to alter the status quo by shifting and realigning the form and function of a targeted system” (Foster-Fishman, Nowell, & Yang, 2007). Considering that community systems changes can produce widespread behavior change and lasting system improvement (Community Tool Box, 2017), research questions were developed to examine dimensional behavioral qualities (e.g., repeatability, temporal extent, temporal locus) of community inputs on resulting implementation of community system changes.

Analytical Strategy

By using a natural science approach and a quasi-experimental design to identify strengthening variables effecting community systems change, initiative sites with differing implementation and accomplishments requires analysis to determine key variables and interactions within a particular context (Lincoln & Guba, 1985; Stroh, 2015). The effects of these process variables on community systems changes were identified through a behavioral design to demonstrate systematic replication.

The strategic approach to this research involves the categorization and analysis of community systems data. The results of this research method provide evidence of linkages between variables influencing the differing implementation of community system changes.

These linkages within and across selected ToD projects was demonstrated by a systems approach to modeling community change using inputs and associated intensity. The predictive value of impact of the systems changes was conducted through an intensity scoring procedure consistent with research by the Center for Community Health and Development (Collie-Akers, Fawcett, & Schultz, 2013; Fawcett, Collie-Akers, Schultz, & Kelley, 2015; Frongillo et al., 2017). This investigation provides an opportunity to integrate the key variables within community-level context involved in intensity in a behavior analytic design. The research outcomes contribute to the behavioral science of community systems by implementation of an inductive approach to classifying and analyzing key variables in community health improvement processes.

Reasoning. Inductive reasoning for determining relationships throughout the analytical process was conducted for coded events. The sites chosen for inclusion served as the unit of analysis. Cross-case and comparative analyses will determine associations between the sites and contextual factors observed in accomplishments. Variations in each site will be determined through synthesizing community systems change data, accomplishments, and archival records. Trustworthiness of data was assessed through member-checking and peer-debriefing. By determining an adequate level of information through expert critiques of the hypotheses, methodology and data, credibility of research findings was established (Lincoln & Guba, 1985).

Sites were coded by initiative characteristics. Code descriptions included variables identified in the inclusion criteria as well as associated dimensions and products, as determined by analytic induction. Codes were further refined, supplemented, or removed as additional information was discovered or deemed redundant. Additionally, research questions were modified in a similar manner. Inter-rater reliability was computed for entries through the CCB;

total scored entry agreements divided by total entries scored by an independent rater to calculate reliability (see Appendix F).

Study Design

Research method. The postpositivist approach applied to selecting appropriate design and analysis of evidence for this research begins with analytic induction. Creswell (2017) summarizes the purpose of utilizing a postpositivist approach to analyze the extent to which causes determine effects or outcomes. Procedures for analytic induction allows for categorization of phenomena across similar dimensions of data.

The procedural process uses exploratory sequential mixed methods to reflect results of inductive analyses explained in behavioral quasi-experimental designs for quantitative analysis. Consistent with the postpositivist philosophy, theory of change is refined by numeric measures of behavior (Creswell, 2017), the behavior in this investigation is reflective of processes communities engaged in to achieve community system changes.

Typical exploratory mixed method procedures include conducting qualitative analysis (analytic induction) followed by quantitative procedures (behavior analyses) to support the theory of change. Hypotheses to be tested are resultant from grounded theory, a design of inquiry to derive a theory of process, action, or interaction grounded in the implementation perspective (Creswell, 2017). The collected data guides the analysis and theories of change. Methods include the selective coding around the community system change – identified as the core variable within this research - categorization of data, memo-ing relationships between variables, and hypothesis testing. Continuous conduction of analyses across sites, codes, and scoring procedures informs the relationships in implementation for this research. Using a natural

science approach to analyze initiative measures with differing implementation and accomplishments, key features within and across contexts will be determined, furthermore the consistency of findings will be demonstrated in behavioral analyses.

Inclusion/Exclusion Criteria. Three sites implementing structural and systems changes in communities were selected from the Together on Diabetes initiative funded by the Bristol-Myers Squibb Foundation. Sites selected from each cluster of grantees were the first initiatives to meet the inclusion criteria across clusters, rather than within each cluster. These clusters include: African American Women Grantees, Diabetes and Depression Initiative, Innovative Intervention Grantees, and Population Health Grantees. Sites were excluded if they implement randomized control trials, targeted clinical interventions, multi-location implementation, or missing inclusion criteria requirements. Inclusion measures required:

- Grant proposals are first reviewed to select sites specifying the use of a community-based approach to intervention
- Proposed objectives for sites are to improve community health outcomes,
- Plan to implement community systems changes, and
- Utilized Center for Community Health and Development at the University of Kansas Community Check Box to record systems change and accomplishment data.

Site Selection. The three sites shown in Appendix B included in this research are Black Women's Health Imperative (BWHI), American Academy of Family Physicians Foundation (AAFPF), and Sixteenth Street (16th Street). The BWHI goals were to improve self-management practices for black women patients who were at least 40 years of age in Washington D.C. AAFPf sought to enhance peer support and community outreach to improve quality of care for minorities in Chicago, Illinois, and 16th Street sought to improve the quality of care for inactive

Hispanic patients in Milwaukee, Wisconsin. BWHI was funded for two years and both AAFP and 16th Street were funded for three years.

Measurement. Capturing implementation of the initiatives required the use of a documentation and feedback system, the Community Check Box provided by the CCHD. The system monitored community changes through event logs which documented codes and dimensions of each event. These dimensions collected information about the event, the location, when it occurred, what was done, who completed it and with whom it was completed, results of implementation, and innovation of the event (e.g. whether or not the event occurred for the first time). These data measures specify factors involved in the implementation of targeted and universal program components.

A benefit of using the workstation systems include a pre-established inter-observer agreement measure in which a secondary independent observer provides event reliability and integrity for system entries. Additionally, archival data served as data measurement. Archival records provided contextual and implementation data through logic models, action planning guides, preliminary evaluation summaries, proposal files, meeting minutes, and procedural information. A variety of data sources to inform logic and strategy for this research include:

- Action planning documents
- Community Check Box accomplishments' logs
- Archival grant records and reports
- Meeting minutes
- Surveys and interview data
- Population-level public health data
- Technical assistance records

Logic Model. Using the BMS TOD theory for change, Figure 3 models the process of behavior change through implementation of community system changes. Inputs consist of CCB evaluation evidence for development activities, services provided, and resources generated for an initiative and qualitative reports (i.e. case studies, progress reports) identifying process barriers and constraints by the initiative. The hypotheses tested in this research follows the logic presented in the model.

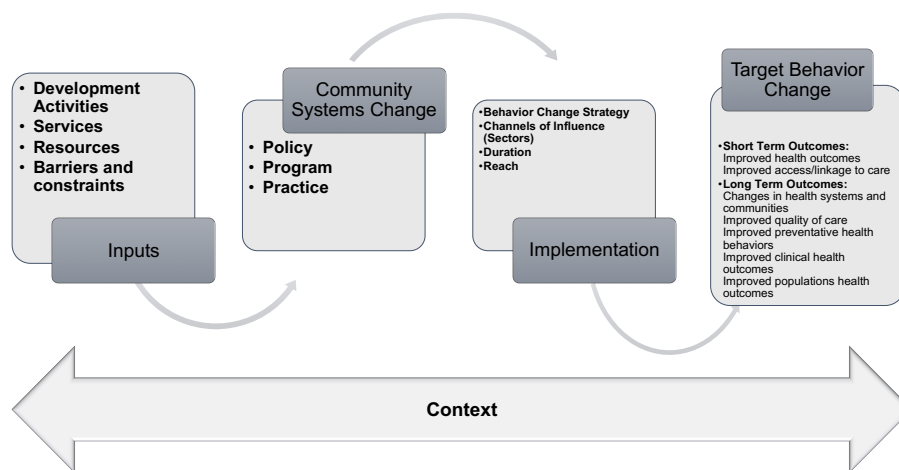


Figure 3. Community System Change Implementation Process Model

Trustworthiness of data. Trustworthiness of data was ensured by inter-observer reliability criteria to address credibility, transferability, dependability, and confirmability. This approach generates confidence in a study through true value, applicability, consistency and neutrality (Lincoln & Guba, 1985). Credibility was established through persistent observation for salience, triangulation (e.g. multiple sources) for contextual validation, member checks in which independent observers respond and critique data and processes, and negative cases analyses to refine research hypotheses based on the results of the data (Lincoln & Guba, 1985). Transferability was addressed through thick descriptions, a method of describing time and

context which is necessary to conclude possible transfers. Dependability of data was established through validation of data and outcomes present in existing literature. Confirmability of data to specify reported information was determined through the following audit trail methods: systematic inquiry of raw data; data reduction and analysis products; synthesis products, process notes, and instruments.

Research Questions and Hypotheses. Research questions and hypotheses to be considered:

1) How does temporal variation in implementation effect more or higher-quality community system changes? More variation within the sequence leads to more or higher quality community systems changes;

2) How does the distribution of inputs relate to implementation of more or higher-quality community system changes? Greater distribution of inputs leads to more or higher-quality systems changes.

Procedure

Analytic Induction. The hypotheses to be tested within the framework of change with each case (i.e. site) serves as the unit of analysis. Each case will be studied against the hypotheses to determine fit and subsequent cases will provide practical certainty (Robinson, 1951). As an inductive approach, the hypotheses, concepts, and relationships under study were modified as required by the application of negative cases.

Sites were coded by initiative characteristics to produce categories for comparison. The codes in which categories were operationally defined are found in Appendix A. The quality of community systems changes will be determined through the following method. Community systems changes recorded within the CCB for each site were scored by intensity to determine potential value and progress made from collaborative action (Collie-Akers, Fawcett, & Schultz,

2013). The dimensions of intensity include duration as event occurrence (e.g. one-time, ongoing), reach as the proportion of the total target population engaged in the change, and type of behavior change strategy. Numeric values are assigned to each dimension of the community systems change by relative strength. The dimension values are summed to provide the intensity score.

Duration was scored high (1.0) if the event is ongoing, medium (0.55) if it occurs more than once in a year, and low (0.1) if the event occurs once. Reach was scored as high (1.0) if 21% or more the population experienced the change, medium (0.55) if 6%-20% of the population are exposed, and low (0.1) if 0-5% of the population are exposed to the change. The strategy was scored high (1.0) if policies and systems, consequences, and access, opportunities and barriers are modified. Strategy was scored medium (0.55) if services and supports are enhanced, and low (0.1) if information is provided and skills are enhanced. The intensity scores represent the quality and projected strength of an implemented system change.

Interrupted Time Series. Using a quasi-experimental design, the interrupted-time series research design is appropriate for evaluating variables with repeating measures of processes which influence intervention progress within and across unique communities (Jason & Glenwick, 2016). The units of analysis are each initiative which provides comprehensive understanding of unique implementation experiences and outcomes. This design allows for the examination of measures and community system changes over time, both within and across cases (Creswell, 2017). Data to be analyzed includes community systems changes implemented, intensity of community system changes, development activities conducted, services provided, and resources generated. Results of this design leads to a temporal analysis of variations in change applied to

the hypothesis. Results also demonstrate whether variables were associated with sites completing more or higher quality systems changes.

Results

Input Analyses

The distribution of inputs and community system changes implemented by each initiative is summarized in Table 1. The 16th street site recorded the most community system changes (n=27), followed by AAFPf (n=23), and BWHI (n=19). BWHI shows a total of 66 inputs, AAFPf shows 347 inputs, and 16th Street shows 77 inputs. The most prevalent input across variables is services provided (n=262). Over the course of initiative evaluation, AAFPf recorded the most inputs of all sites per input type and the 16th Street project demonstrated the most recorded community system changes. BWHI recorded less development activities and community system changes overall. Additionally, BWHI did not record any resources generated. Table 1 shows services provided occurred most during intervention for the BWHI (n=35) and AAFPf (n=210) sites whereas the 16th Street project implemented more development activities (n=51) than other inputs.

Table 1

Distribution of Community Change Variables across Communities (N=3)

Site	Number of Variables				All Variables
	Development Activities	Services Provided	Resources Generated	Community System Changes	
BWHI	31	35	--	19	85
AAFPf	106	210	31	23	370
16th Street	51	17	9	27	104

All Sites	188	262	40	69	559
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Note. Cells containing dashes indicate variables in which a community did not record data in the evaluation system.

The allocation of input efforts per community system change is displayed in Figure 4. An average of 1.3 (SD 2.3) development activities and 1.6 services provided (SD 1.1) preceded a community system change for BWHI. BWHI did not show any resources generated. AAFPF showed an average of 4.0 (SD 6.1) development activities, 5.0 (SD 6.7) services provided, and 1.1 (SD 1.8) resources generated. An average of 1.9 (SD 6.1) development activities, 0.7 (SD 2.7) services provided, and 0.4 (SD 1.0) resources generated.

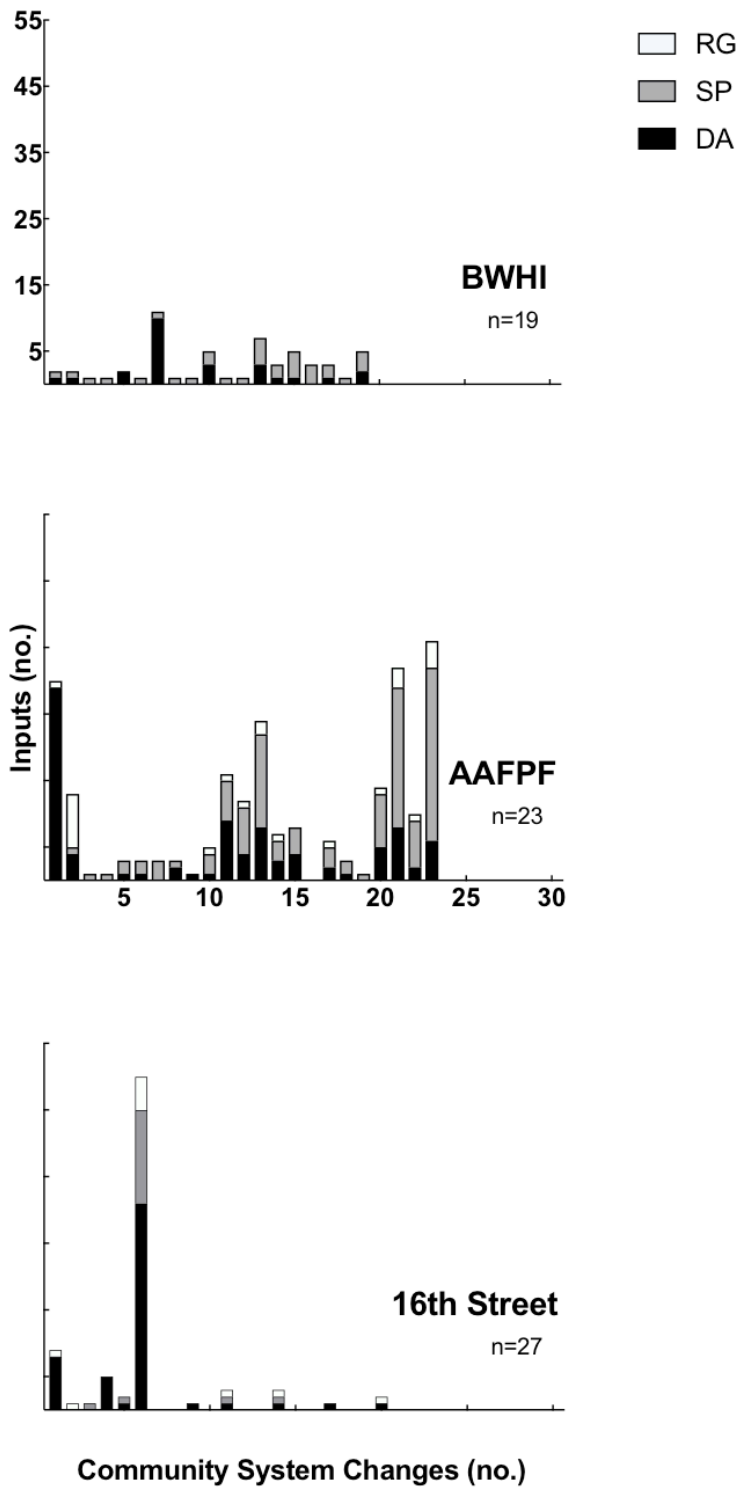


Figure 4. Distribution of inputs by type preceding each implemented community system change per initiative.

Per community system change implemented at each site, the cumulative number of inputs and types preceding a community system change are displayed in Figure 5. Within project, BWHI shows an average of 2.9 (SD 2.7) inputs preceding a community system change. AAFPF recorded an average of 10.1 (SD 10.8) inputs occurring prior to the implementation of a community system change. 16th Street shows an average of 2.9 (SD 9.6) total inputs before a community system change occurs. Across sites, the most prevalent input is services provided followed by development activities. The least prevalent input observed across sites is resources generated. Visually, cumulative inputs increased over time for BWHI and AAFPF sites. The 16th Street site maintained relatively little or no implementation as more community system changes were implemented.

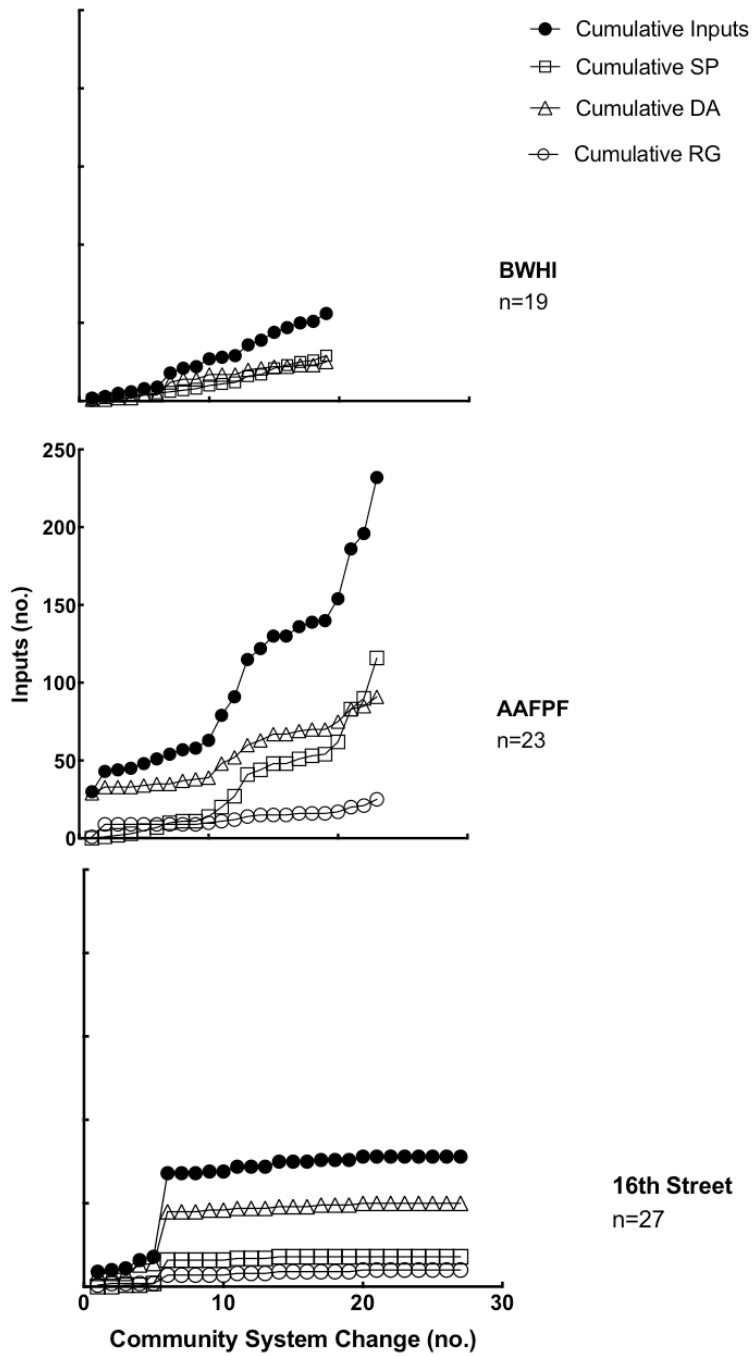


Figure 5. Cumulative number of inputs and community system change across implementation sites

The cumulative record of community system changes and inputs is shown in Figure 6, which demonstrates the collective implementation efforts across years for each initiative. BWHI showed implementation efforts from 2011 – 2014. This site implemented 5 inputs and 3 community system changes in 2011, 27 inputs and 9 community system changes during 2012, 61 inputs and 7 community changes in 2013. In 2014, BWHI implemented 5 development activities contributing to cumulative inputs. The AAFPF site efforts spanned 2011 – 2015 with 70 inputs implemented in the first year. The second year shows 70 inputs and 12 community system changes implemented, followed by 153 inputs and 11 community system changes in 2013. Inputs completed by AAFPF during 2014 and 2015 are, 83 and 9, respectively. 16th Street implemented 9 inputs for each of the first two years. In 2013, 5 community system changes and 70 inputs were recorded, followed by 8 and 12, and 14 and 4 by the end of 2015. The most prevalent input for AAFPF and BWHI is services provided. The most prevalent input for 16th Street is development activities. The most observable change in inputs occurred during 2013 for all sites.

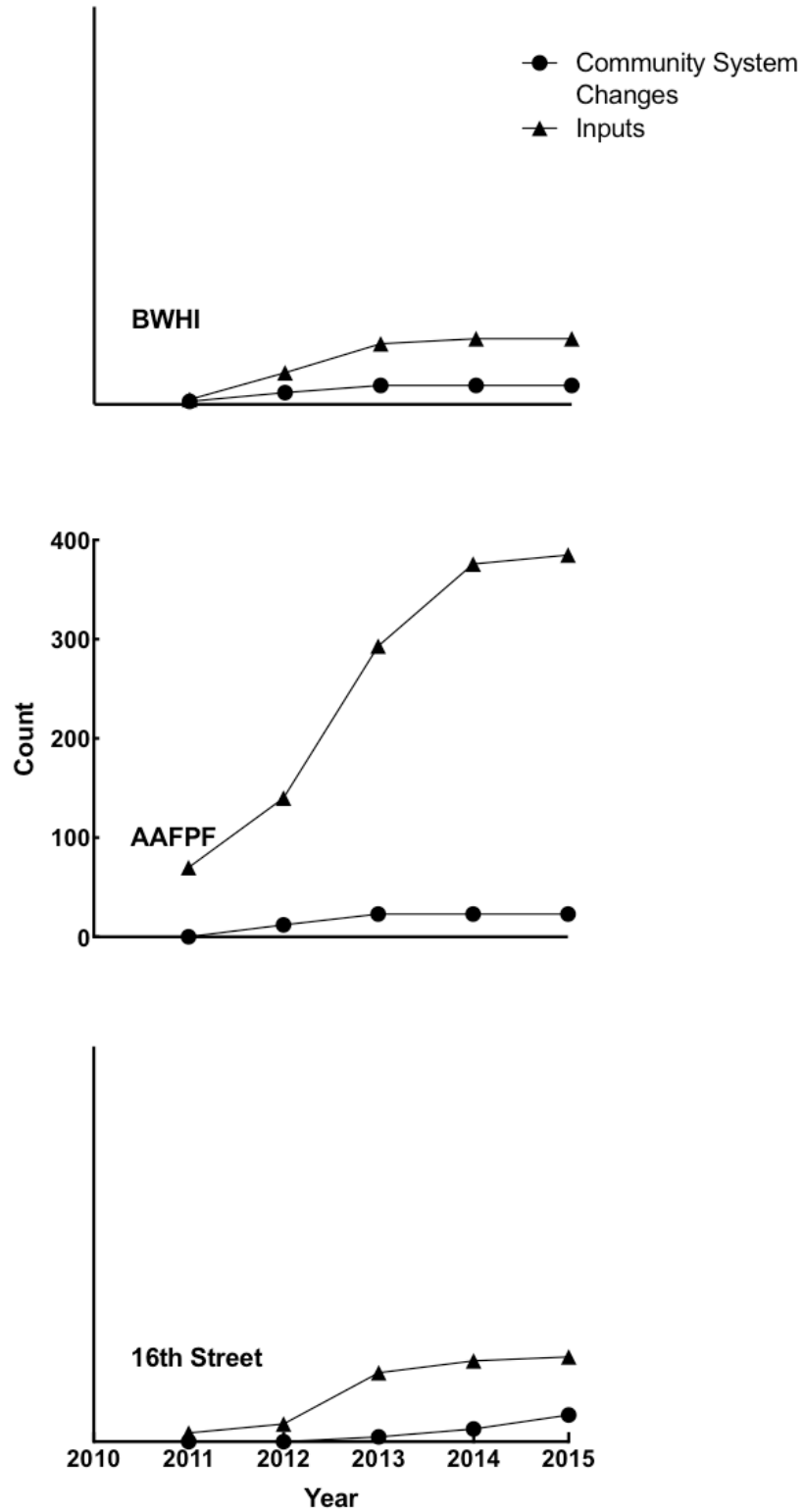


Figure 6. Cumulative record of inputs and community system changes per year

Inputs and Community System Changes Associations

A regression analysis to observe any associations between inputs and community system changes per year is demonstrated in Figure 7. Inputs and community system changes are plotted on the y axis as variables and time in years is shown on the x axis. Community system changes were observed as significant associations for 16th Street across years (r square = 0.931).

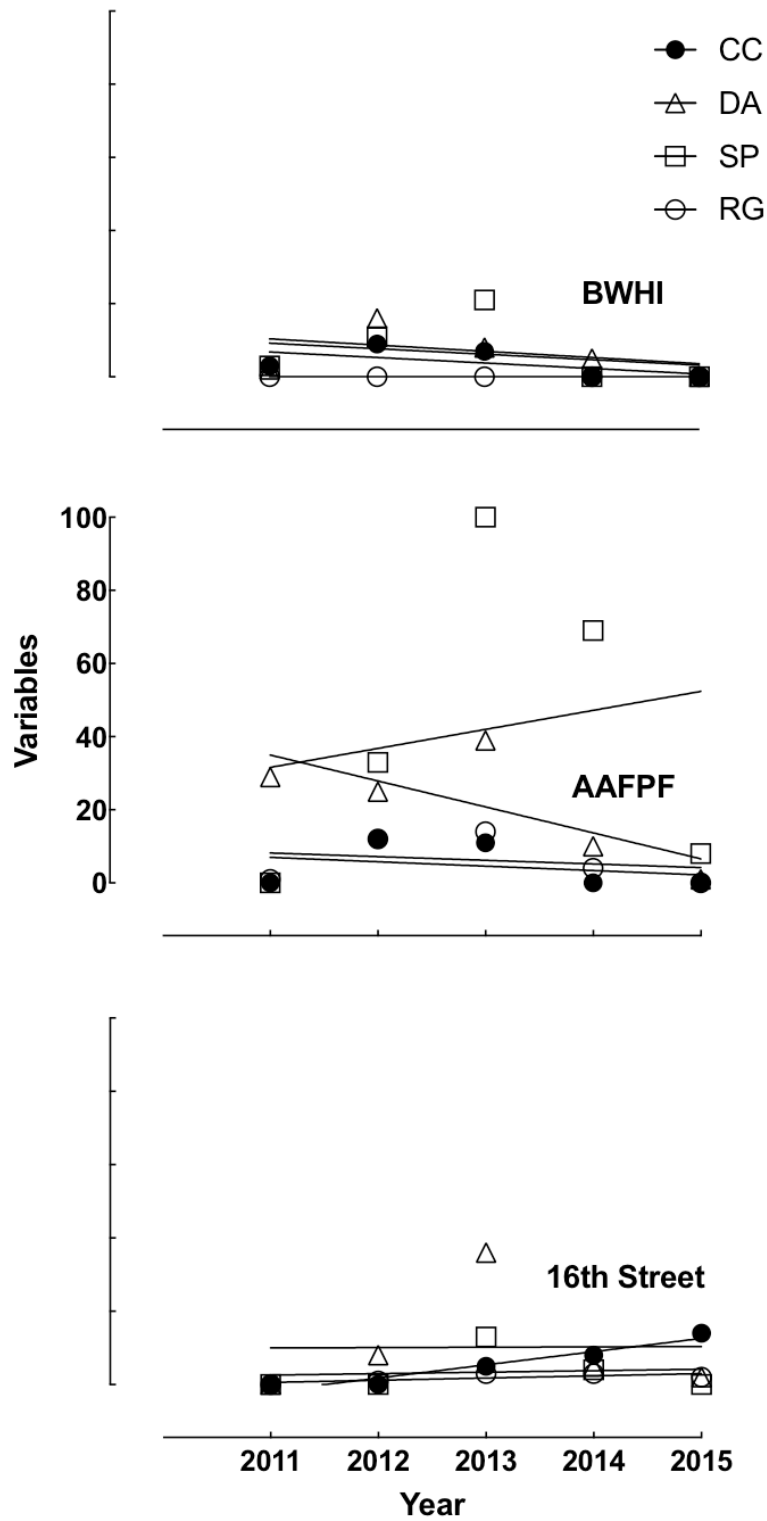


Figure 7. Regression analysis between all implemented variables per year across sites.

The number and type of inputs occurring over time between systems changes is shown in Figure 8. The x axis shows days between implementation of two systems changes by the y axis as number of inputs occurring within the timeframe. A standard linear regression was fit to the data to determine associations between inputs and interresponse times. BWHI did not show interresponse time associations with any variable. Resources generated (r square = 0.938), and development activities (r square = 0.253) showed associations to interresponse times for the AAFPF site. All variables recorded for 16th Street showed associations per interresponse time as follows: Resources generated (r square = 0.683); services provided (r square = 0.678); and development activities (r square = 0.713).

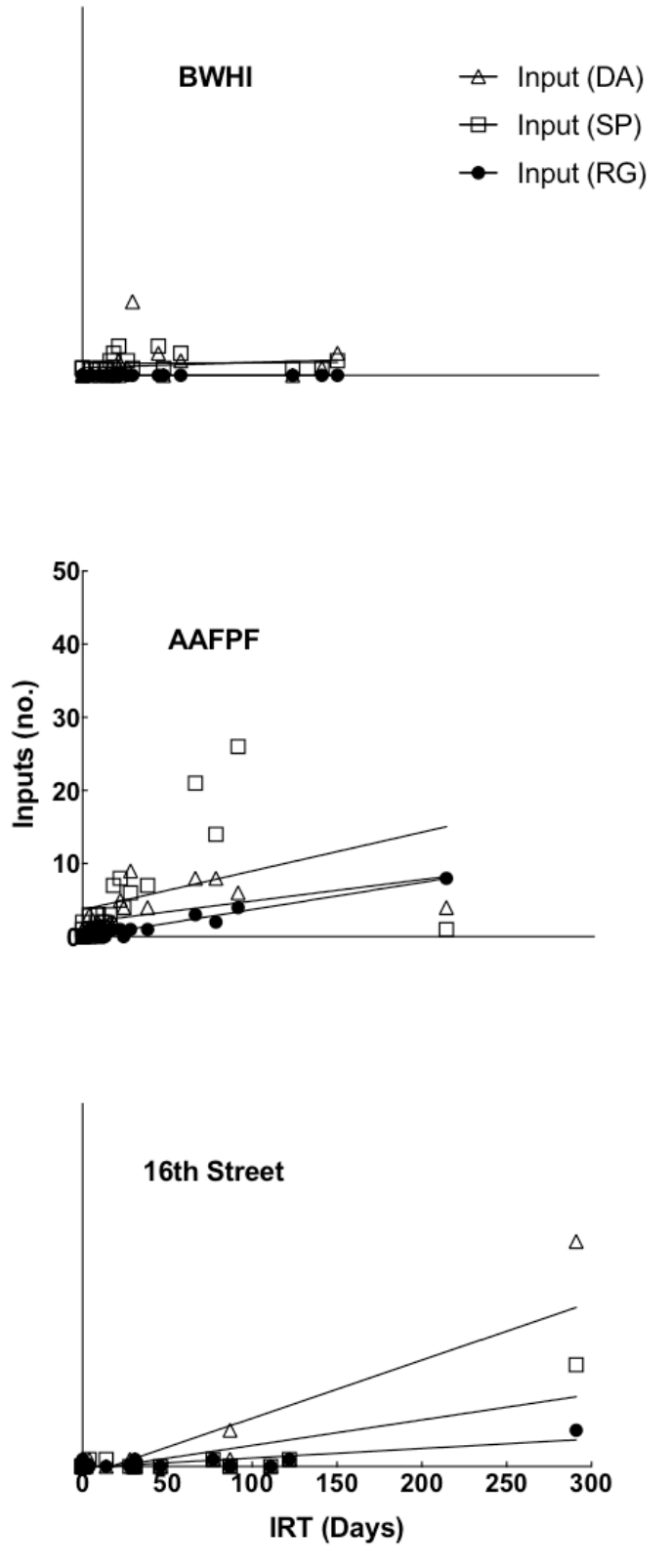


Figure 8. Regression analysis of inputs and interresponse times (IRT).

The intensity score distribution for each community system change implemented per initiative is displayed in Figure 9. Calculations entered for each intensity scores per initiative can be found in Appendix C and D. The mean intensity for BWHI was observed at 1.1 (SD 0.46) and the initiative never completed the highest attainable intensity score. The highest score attained by BWHI was 2.1 and the mode intensity was 1.2. AAFPF and 16th Street both implemented community system changes with the highest score (3.0), with a frequency of 4 and 3, respectively. The lowest score for AAFPF was observed once at 0.8. The most observed intensity score for the same site was 2.1, with a mean of 1.9 (SD 0.68). The lowest score for 16th Street was observed twice at 0.8. The most frequent score was 2.1 with a mean score of 2.1 (SD 0.50).

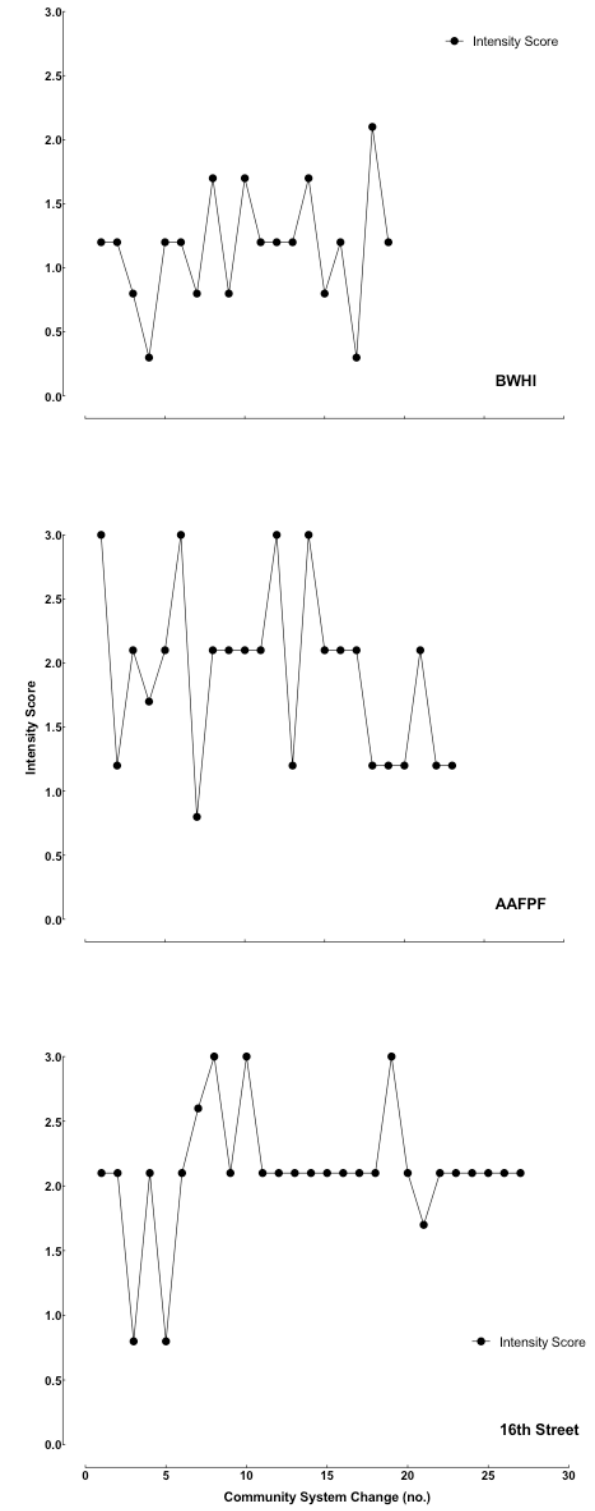


Figure 9. Distribution of intensity scores for each community system change initiative.

Associations between variables across sites

Per community system change implemented, the association between cumulative intensity and interresponse times are displayed across community system changes (Figure 10). The lighter area represents cumulative intensity and black area represents interresponse time. The BWHI site shows four interresponse times which noticeably exceed cumulative intensity. These data points occur between the 1st and 2nd community system change implemented (n=139), the 3rd and 4th community system change (n=47), the 7th and 8th community system change (n=122) and the 9th and 10th community system change (n=148). AAFP shows one data point outlying cumulative intensity between the 1st and 2nd community system change (n=213). The 16th Street site shows five interresponse times with greater outlying intensity. These occur between the 3rd and 4th community system change (n=87), the 5th and 6th community system change (n=291), the 8th and 9th community system change (n=87), the 10th and 11th community system change (n=77), and the 13th and 14th community system change (n=122). The dark grey shaded area followed with a dark grey line shows the cumulative number of inputs recorded. BWHI shows a similar trend in implementation of inputs and intensity. AAFP shows greater cumulative implementation of inputs, above the intensity value. 16th Street displays an increasing intensity value without variability in cumulative inputs.

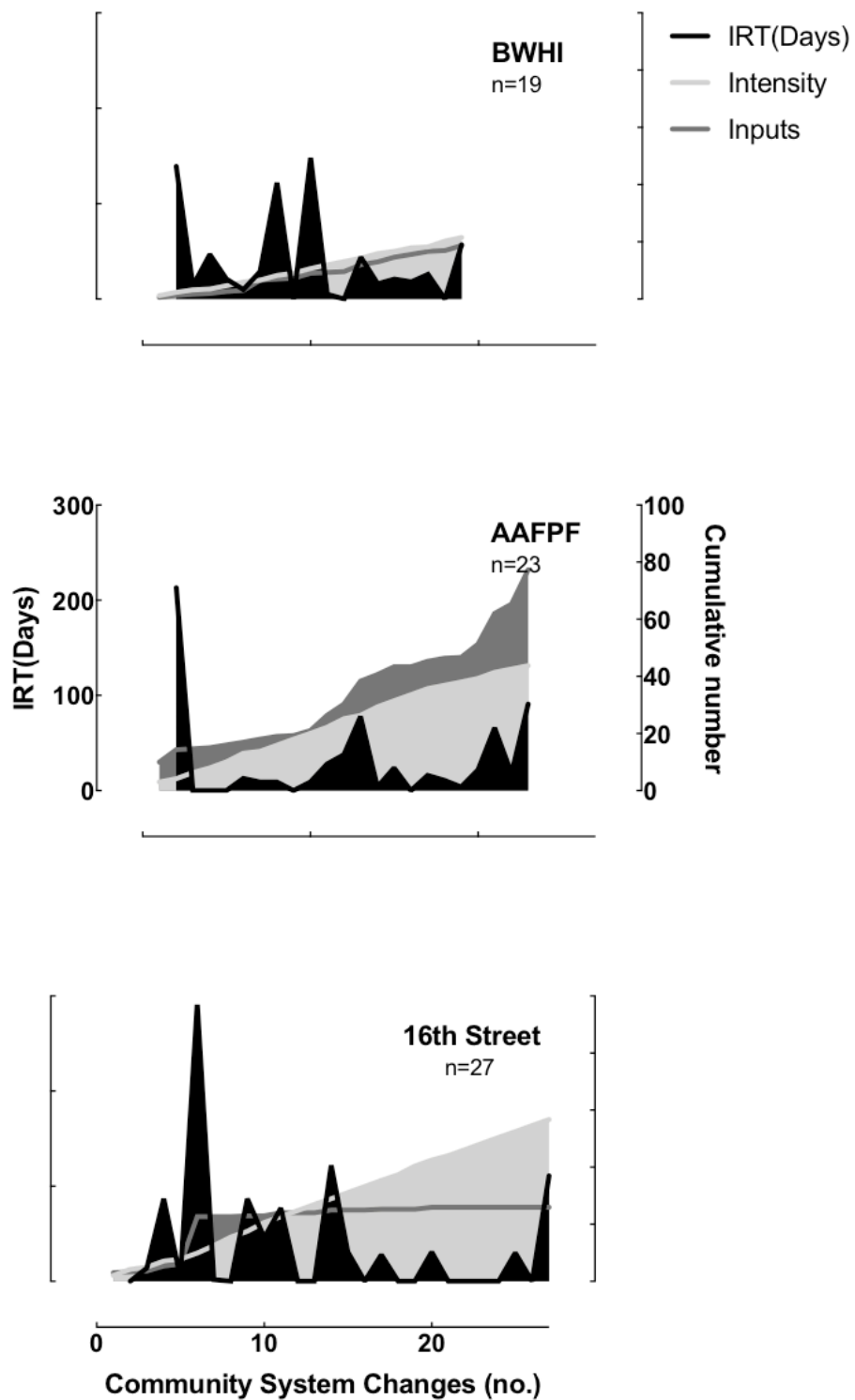


Figure 10. Cumulative intensity and inputs by interresponse times per community system change.

The number of inputs occurring within each year in relation to cumulative intensity for each initiative is shown in Figure 11. Intensity increases across time for all initiatives. Both AAFPF and BWHI show leveled intensity scores from 2013 – 2015. A positive trend is observed for 16th Street from 2012 – 2015. All inputs show an increase in implementation from 2011 – 2013 and a decrease from 2013 – 2015. Peak development activity implementation occurred in 2012 for BWHI and 2013 for both AAFPF and 16th Street. The peak year for services provided implementation occurred in 2013 for all sites. Resources generated as observed most in 2013 for both AAFPF and 16th Street.

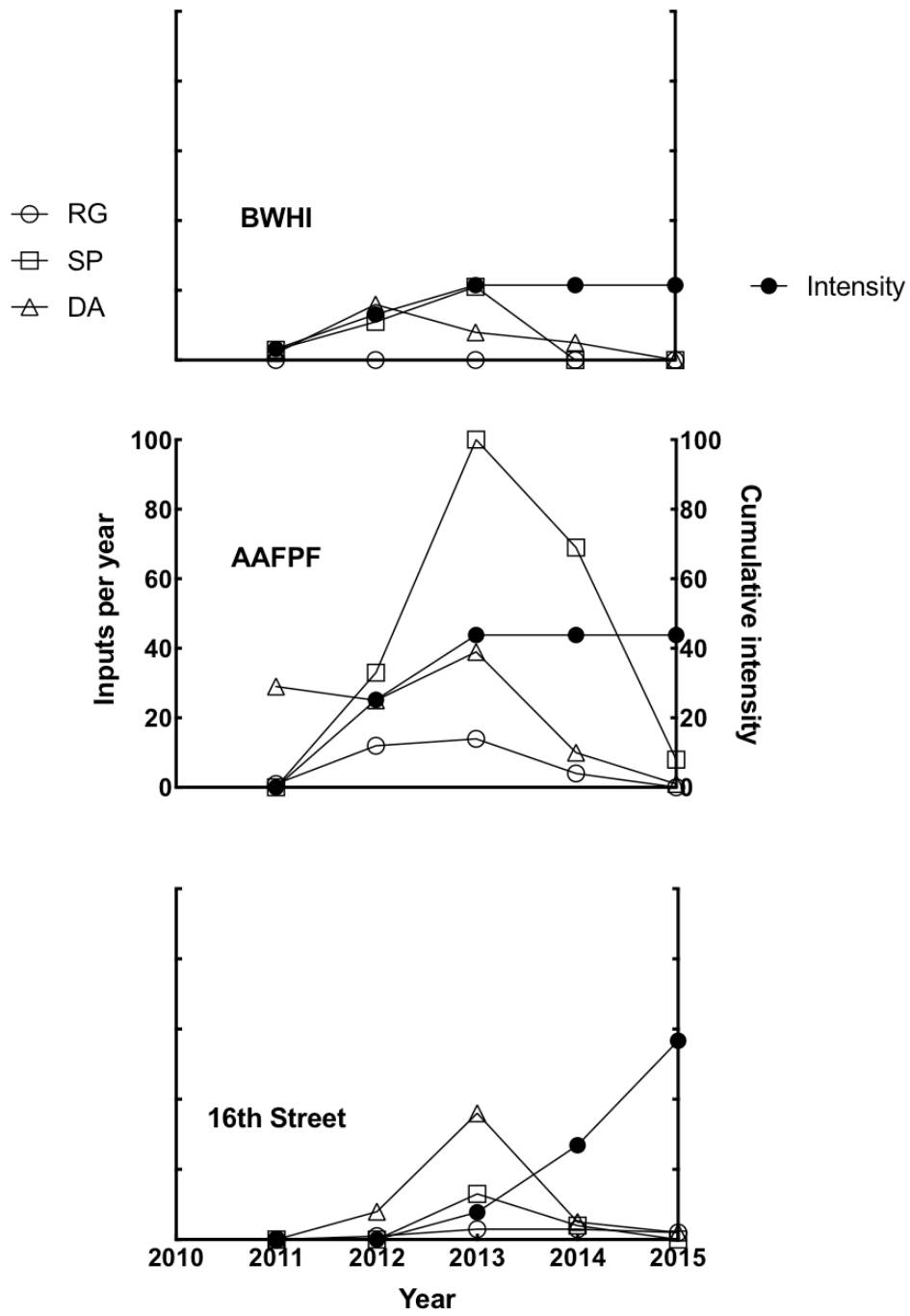


Figure 11. Frequency of inputs per year in relation to cumulative intensity scores.

The following figure shows the proportion of inputs implemented each year by average intensity per year. Figure 12 demonstrates the allocation of efforts per site and the mean intensity value per implementation year. BWHI shows a stable three years of low mean intensity from 2011 – 2013. The year 2013 represents over half of services provided implemented for the initiative. Half of development activities implemented by the initiative occurred in 2012. AAFP shows declining average intensity from 2012 – 2013. The greatest proportion of all efforts is shown in 2013. The 16th Street site shows increasing intensity from 2013 – 2014 and a slight decrease within the medium intensity range from 2014 – 2015. Most of the initiatives inputs across years were implemented in 2013, but the highest observed intensity average occurred in the following year.

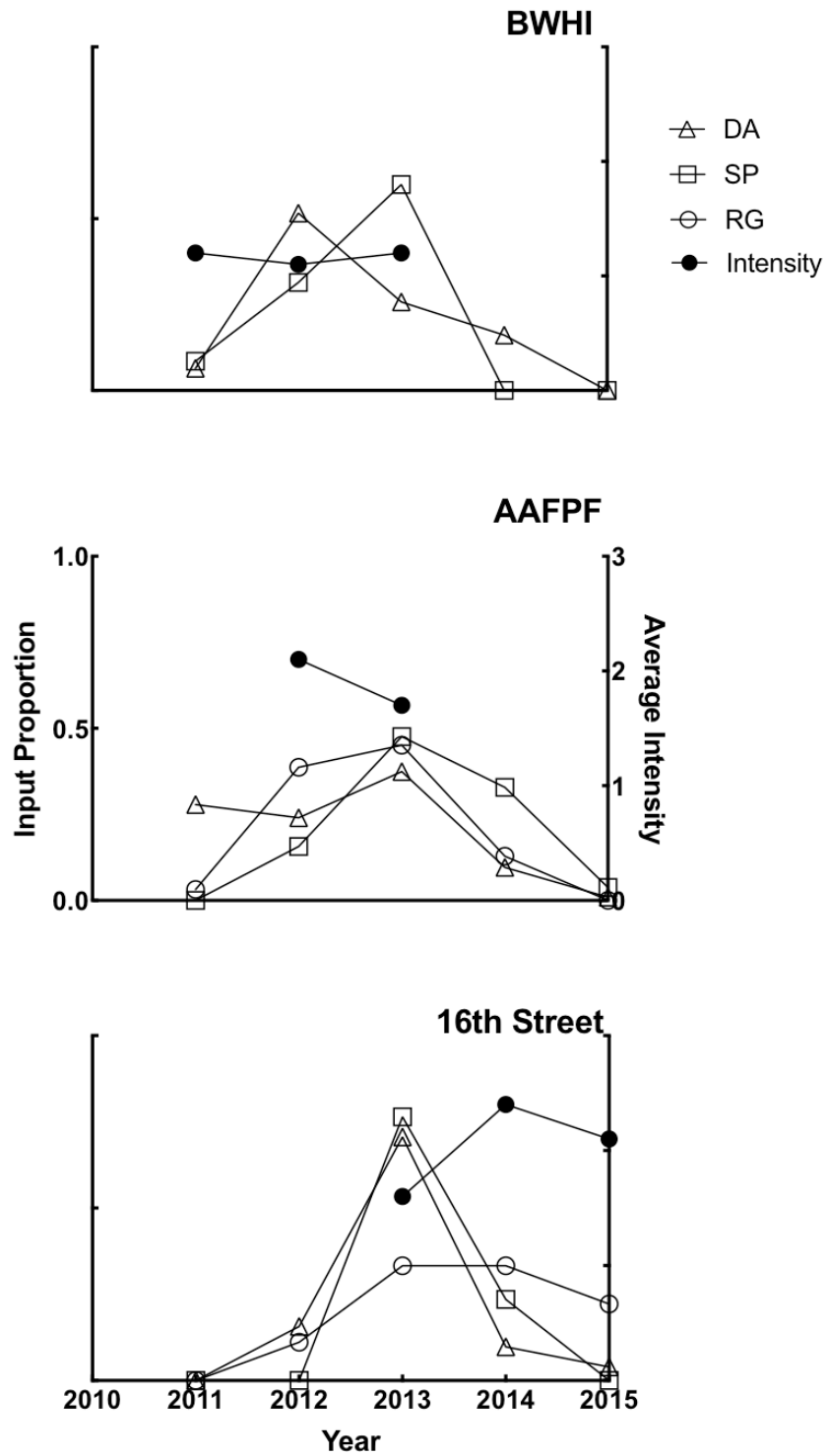


Figure 12. Proportion of inputs by average intensity scores per year.

Discussion

This paper summarizes the analysis of community initiative input efforts and community system improvement by examining the intensity scores of three interventions. Although not all community system changes have equal influence, research shows various strategies and durations in effect have different amounts of influence on outcomes. This study showed sites with more and higher quality community system changes generated resources during implementation. BWHI, the only site that did not have resources completed the least amount of community system changes with the lowest intensity of the three sites. Additionally, the site did not show any associations with inputs to interresponse times or variables across years when the other two sites did. The findings suggest the generation of resources and allocation of inputs between community system changes are associated with greater intensity.

This study found a greater amount and a positive trend for cumulative inputs within the AAFPF site prior to each community system change, but this did not show a relationship with the number of community system changes implemented across sites reliably. The most prevalent input was observed as services provided for AAFPF and BWHI and more development activities were observed for the 16th Street site. Inputs were not significantly associated variables per year for any site, indicating the change in input implementation alone does not have a relationship to years each site recorded activity.

Interresponse times – defined as the number of days between the implementation of two community system changes – demonstrated significant associations for both AAFPF and 16th Street. AAFPF showed resources generated and development activities, and 16th street demonstrated resources, services, and development activities were significantly associated with interresponse times. This finding suggests there is a relationship between resource and

development activities that occur between the implementation of two community system changes.

Community System Changes. Per year, only community system changes demonstrated significant associations for the 16th Street site. The 16th street site demonstrated the most community system changes and highest intensity scores and BWHI showed the lowest. The implementation of inputs and community systems changes as a function of each year resulted in only 16th Street showed associations. This suggests that more and higher-quality CSCs implemented each year does not require more significant efforts from the amount of inputs occurring this particular site.

Inputs and Outputs. Both AAFPF and BWHI's highest annual intensity and services provided inputs occurred in the same year. AAFPF also showed highest development activity and resources generated per year in the same year as the highest annual intensity. 16th Street showed its highest implementation for all inputs two years prior to the highest annual cumulative intensity. Inputs occurring at the highest proportion for AAFPF saw average intensity declining. BWHI showed the lowest annual average intensity when highest development activity and increasing services provided were occurring. The majority of the proportion of inputs occurred a year before an increase in 16th Street average intensity. This finding suggests average intensity increases with more inputs occurring prior to community system change efforts.

The analyses suggest that more inputs may not lead to more implementation of community system changes. Completing more and higher quality community system changes represents effective implementation by 16th Street. Between implementation of two community system changes, AAFPF showed associations with efforts allocated to generating resources and providing services. The 16th Street site showed associations with allocated efforts to all inputs

between community system changes. Because BWHI didn't show any associations in this regard, the findings suggest allocating more activity between implementation of new or modified programs, policies, and practices may increase the likelihood of their implementation. The outcomes produced by 16th Street are consistent with literature, suggesting community-based interventions at a neighborhood level may be more effective than community-based interventions that are top down at the community level, as demonstrated by AAFPF and BWHI (Collie-Akers, Fawcett, & Schultz, 2013)

Intensity Scoring.

Mean intensity scores for BWHI was 1.1, AAFPF 1.9, and 16th Street was 2.1, where 16th Street was able to obtain more and higher quality community system changes. BWHI showed greatest IRT outliers occurred four times, AAFPF showed one, and 16th street showed five. Across outlying IRTs, cumulative intensity was greater than cumulative inputs for BWHI. Cumulative inputs were greater than cumulative intensity throughout all AAFPF implementation. Cumulative intensity was greater than cumulative inputs for only the first and last IRT within the 16th Street site, in which case inputs exceeded intensity indicating a change in allocation of efforts. These findings suggest sites with response allocation to either intensity or inputs does not produce the highest number of community system changes. The findings from 16th Street indicate change in response allocation may be related to the increase cumulative intensity scores.

This study examined the relationships between development activities, services provided, and resources generated as inputs and community system changes and their projected influence as outputs within and across three implementation sites.

Limitations. Lack of research surrounding community collaborative efforts and community system change intensity poses problems for measuring progress toward equity.

Findings related to community system change intensity have mixed results (Anderson-Carpenter, 2014). Therefore, this study has several limitations worth noting.

First, data used in this study is contingent on initiative recording, as well as investigations of permanent products (e.g., newsletters, meeting minutes) kept by the coalition and partnership staff. Documentation of the intervention and related activities is only as complete as the initiative's ability to complete entries. The inability to determine initiatives' recording contingencies prevents the analysis of selection of entries which can further contribute to understanding differential need and sufficiency for more or higher quality community system changes. However, the amount and quality of system changes may be related to learning history and development processes used to implement an initiative and this information was not provided in this analysis (e.g., experience, planning, target geographic region).

Furthermore, the intensity score procedure has demonstrated validity and generality in few subsequent studies. Although the National Institutes of Health (NIH) utilized the Healthy Communities Study protocol, additional dimensions of intensity may need to be explored (Anderson-Carpenter, 2016). Variability in implementation length (e.g. 2 years versus 3 years), inputs, and community system changes does not allow for direct comparisons of initiative activity.

Strengths. Strengths of this study include assessment of initiatives allocation of efforts and community system changes in a quasi-experimental design. The methodological approach to analyzing differences in community implementation shows increased rigor as opposed to qualitative survey summaries and analyses. Using this methodology, where efforts were allocated across implementation may have associations with the community system change outcomes.

Identifying associations between activities across three sites with differing implementation was accomplished. Identifying activity occurring during interresponse times of two community system changes informs research of temporal associations related to initiative efforts. Steady implementation and increased inputs were not associated with more or higher quality community system changes. Community system changes and inputs demonstrated linear functions of temporal relationships across time for 16th Street. Community system changes showed positive relationships for this site annually. Inputs showed functional associations within site demonstrating both higher intensity and more community system changes for two sites.

Analyzing the allocation of inputs across time and communities shows the implementation of procedures that are easily replicated and generalizable across community initiatives for influence comparison. Employing analyses across initiatives with different partnerships, strategies, and geographical regions in a standard assessment increased the generality of findings, although more work is needed to draw causal inferences.

Future research. Future research should consider the documentation of interventions and ensuring completeness of input, output, and outcome fields prospectively. The relationships demonstrated between and across variables can reflect accurate measures as a coalition progresses throughout implementation. A prospective analysis of relationships between community health improvement accomplishments, system changes and outcomes aligned with the initiatives' specific objectives will further increase the strength of findings.

Multiple strategies can be included in the implementation of a single community system change. Future studies should consider methods for examining comprehensive effects that may be present in these events. Future studies should aim to increase sample size of interventions to enhance the power of associations between variables and community system changes in these

analyses, a stronger statistical analysis may inform a variety of audiences of a larger scale influence by new programs, policies, or practices.

Additionally, researchers would benefit from an evaluation of the use of funds within initiatives to determine how resources are allocated and generated across intervention efforts. Determining the relationship to community system change intensity by identifying the use of funds will further contribute to research findings by allowing the determination of value per input and community system change as completed. Utilizing a behavioral economic approach to resource allocation can yield fruitful knowledge of the implementation of initiatives priorities, alignment of funds, and determine relationships to community system change intensities.

Conclusion

This study successfully replicated an intensity score procedure in three Type-2 diabetes initiatives. The most influential site appeared to be the smallest in partnership size, thus funders and implementers should consider grassroots organizations' capacity to bring about more and higher quality community system changes. Furthermore, this study demonstrates relationships between common variables and the predictive intensity of community system changes. This research demonstrates variability in implementation across sites and completion of more inputs do not equate more or higher quality community system changes. Research shows measures of intensity provides feedback on community-based partnerships' progress and creates opportunities for adjustments as necessary, yielding adaptive interventions for a community. By observing a partnership's allocation of activities, predictions towards higher quality community system changes may be made.

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Appendix A

Together on Diabetes Analysis Codes and Site Examples

Code	Activity	Site	Example
CC	Community/System Change	16th Street Community Health Center	Sixteenth Street staff implemented a practice change of refining electronic health record reports to help identify patients that have fallen out of care.
DA	Development Activity	Black Women's Health Imperative	Imperative staff members traveled to St. Louis, MO to train 4 new lifestyle coaches for the National Diabetes Prevention Program in a 2-day training. This activity helped the Community Wellness Project build their capacity.
SP	Services Provided	American Academy of Family Physicians Foundation	Participated in a community resource fair and provided participants with information on diabetes prevention and control. Screenings of BMI, Blood Pressure and Glucose. 65 participated.
RG	Resources Generated	16th Street Community Health Center	Leveraged the Together on Diabetes grant to secure local funding from the GE Foundation for \$200,000 to partially support staff of the diabetes team, increase access to comprehensive services, improve patient-provider interactions, improve the use of group services to serve more patients through improved efficiencies.

Appendix B

Description of Study Sites

Site	Organization	Location	Partnerships	Target Population	Target Region	Funding Period	Extension	Grant Funding
BWHI	Public Education and Policy Organization	Washington D.C.	Greater Mt. Calvary Holy Church Union Temple Baptist Church in Georgia Avenue Rock Creek East Family Strengthening Collaborative in Matthews Memorial Baptist Church Unity Health Care	African American Women	Washington D.C.	May 11 - Dec 13	--	\$ 305,000.00
AAFPF	Medical Center/Clinic Federally Qualified	Chicago, IL	University of North Carolina Gillings School of Public Health Transformed, National Council of La Raza American Association of Diabetes Educators	Latino American Adults	Chicago/Lower West Side	Jan 11 - Dec 14	Dec-15	\$ 5,239,876.00
16th Street	Health Center	Milwaukee, WI	--	Uninsured Hispanic Population	South Side Milwaukee	Jan 12 - Dec 15	--	\$ 378,650.00

Note: Dashes within cells indicate data is not provided for the respective column.

Appendix C

Characterization Procedures for Intensity Scoring
Retrieved from Collie-Akers, Fawcett, & Schultz, 2014

Collie-Akers et al. • Measuring progress on collaborative action

TABLE 1. Characterization and weighting of domains used to rate the “intensity” of a community or system change brought about by collaborative action in a community health effort, Kansas City, Kansas, United States, 2009–2012

Dimension	Scoring rubric (0 = lowest intensity to 1 = highest intensity)	Rationale
Duration	<p>High (1.0): Ongoing (i.e., occurring throughout the year of the project/study period)</p> <p>Medium (0.55): Occurring more than once during the given year</p> <p>Low (0.1): One-time event</p>	Emerging evidence and expert consensus suggest that community/system changes that are sustained are more likely to affect behavior change and population-level outcome.
Reach	<p>High (1.0): 21% or more of the population to be exposed to the change</p> <p>Medium (0.55): 6%–20% of the population to be exposed to the change</p> <p>Low (0.1): 0%–5% of the population to be exposed to the change</p>	Emerging evidence and expert consensus suggest that exposure to community/system changes is important to affect outcomes.
Strategy	<p>High (1.0): Modifies policies and systems; changes consequences (e.g., incentives, enforcement); modifies access, opportunities, and barriers</p> <p>Medium (0.55): Enhances services and support</p> <p>Low (0.1): Provides information and improves skills</p>	Emerging evidence and expert consensus suggest that community/system changes addressing policy and access/opportunity are more likely to achieve outcomes.

Appendix D

Community System Change Intensity Scores (N=69)

	Site	Date of Activity	Intensity Measures			Intensity Score
			Duration	Reach	Behavior Change Strategy	
1	BWHI	6/1/13	1	0.1	0.1	1.2
2	BWHI	4/5/13	0.1	0.1	0.1	0.3
3	BWHI	4/5/13	1	0.1	1	2.1
4	BWHI	3/10/13	1	0.1	0.1	1.2
5	BWHI	2/20/13	0.55	0.1	0.1	0.8
6	BWHI	1/30/13	0.55	0.1	1	1.7
7	BWHI	1/14/13	1	0.1	0.1	1.2
8	BWHI	12/1/12	1	0.1	0.1	1.2
9	BWHI	12/1/12	1	0.1	0.1	1.2
10	BWHI	11/26/12	0.55	0.1	1	1.7
11	BWHI	7/1/12	1	0.1	0.55	1.7
12	BWHI	7/1/12	0.55	0.1	0.1	0.8
13	BWHI	3/1/12	0.55	0.1	0.1	0.8
14	BWHI	2/1/12	0.1	0.1	1	1.2
15	BWHI	1/22/12	0.55	0.1	0.55	1.2
16	BWHI	1/1/12	0.1	0.1	0.1	0.3
17	BWHI	11/15/11	0.55	0.1	0.1	0.8
18	BWHI	11/1/11	1	0.1	0.1	1.2
19	BWHI	6/15/11	1	0.1	0.1	1.2
20	AAFPPF	10/15/13	1	0.1	0.1	1.2
21	AAFPPF	7/16/13	1	0.1	0.1	1.2
22	AAFPPF	6/28/13	1	0.1	1	2.1
23	AAFPPF	4/23/13	1	0.1	0.1	1.2
24	AAFPPF	4/1/13	1	0.1	0.1	1.2
25	AAFPPF	3/28/13	1	0.1	0.1	1.2
26	AAFPPF	3/17/13	1	0.1	1	2.1
27	AAFPPF	3/1/13	1	0.1	1	2.1
28	AAFPPF	3/1/13	1	0.1	1	2.1
29	AAFPPF	2/5/13	1	1	1	3
30	AAFPPF	2/1/13	1	0.1	0.1	1.2
31	AAFPPF	11/15/12	1	1	1	3
32	AAFPPF	10/8/12	1	0.1	1	2.1

Count	Site	Date of Activity	Intensity Measures			Intensity Score
			Duration	Reach	Strategy	
33	AAFPPF	9/10/12	1	0.1	1	2.1
34	AAFPPF	9/1/12	1	0.1	1	2.1
35	AAFPPF	9/1/12	1	0.1	1	2.1
36	AAFPPF	8/23/12	0.55	0.1	0.1	0.8
37	AAFPPF	8/14/12	1	1	1	3
38	AAFPPF	8/1/12	1	0.1	0.1	1.2
39	AAFPPF	8/1/12	1	0.1	1	2.1
40	AAFPPF	8/1/12	1	0.1	0.55	1.7
41	AAFPPF	8/1/12	1	0.1	1	2.1
42	AAFPPF	1/1/12	1	1	1	3
43	16th St	8/20/15	1	0.1	1	2.1
44	16th St	5/1/15	1	0.1	1	2.1
45	16th St	5/1/15	1	0.1	1	2.1
46	16th St	4/1/15	1	0.1	1	2.1
47	16th St	4/1/15	1	0.1	0.55	1.7
48	16th St	4/1/15	1	0.1	1	2.1
49	16th St	4/1/15	1	0.1	1	2.1
50	16th St	4/1/15	1	0.1	1	2.1
51	16th St	3/1/15	1	0.1	1	2.1
52	16th St	3/1/15	1	0.1	1	2.1
53	16th St	3/1/15	1	1	1	3
54	16th St	2/1/15	1	0.1	1	2.1
55	16th St	2/1/15	1	0.1	1	2.1
56	16th St	1/1/15	1	0.1	1	2.1
57	16th St	9/1/14	1	0.1	1	2.1
58	16th St	9/1/14	1	0.1	1	2.1
59	16th St	9/1/14	1	0.1	1	2.1
60	16th St	6/16/14	1	1	1	3
61	16th St	5/1/14	1	0.1	1	2.1
62	16th St	2/3/14	1	0.55	1	2.6
63	16th St	2/3/14	1	1	1	3
64	16th St	2/1/14	1	0.1	1	2.1
65	16th St	4/16/13	0.55	0.1	0.1	0.8
66	16th St	4/12/13	1	0.1	1	2.1
67	16th St	1/15/13	0.55	0.1	0.1	0.8
68	16th St	1/1/13	1	0.1	1	2.1
69	16th St	1/1/13	1	0.1	1	2.1

Appendix E

Regression Analysis of Community System Change over Years

Site	Slope 95% CI	R Square	Equation	p value
16th Street	1.8 to 5.4	0.931	$Y = 3.6 * X - 5.4$	0.008
AAFPPF	-8.19 to 5.79	0.0905	$Y = -1.2 * X + 8.2$	0.623
BWHI	-5.37 to 2.37	0.337	$Y = -1.5 * X + 8.3$	0.305

Regression Analysis of Input Frequency within Interresponse Time

Site	Input	Slope 95% CI	R Square	Equation	p value
16th Street	Development Activity	0.0585 to 0.101	0.713	$Y = 0.0798 * X - 1.34$	<.001
	Services Provided	0.0249 to 0.0453	0.678	$Y = 0.0351 * X - 0.604$	<.001
	Resources Generated	0.00933 to 0.0168	0.683	$Y = 0.0131 * X - 0.137$	<.001
	All Inputs	0.0939 to 0.162	0.714	$Y = 0.128 * X - 2.08$	<.001
AAFPPF	Development Activity	0.00586 to 0.0532	0.253	$Y = 0.0295 * X + 1.94$	0.017
	Services Provided	-0.00723 to 0.114	0.144	$Y = 0.0533 * X + 3.69$	0.081
	Resources Generated	0.033 to 0.042	0.938	$Y = 0.0375 * X - 0.0233$	<.001
	All Inputs	0.0412 to 0.2	0.335	$Y = 0.12 * X + 5.61$	0.005
BWHI	Development Activity	-0.01956 to 0.03358	0.01916	$Y = 0.007008 * X + 1.054$	0.584
	Services Provided	-0.01176 to 0.01364	0.00154	$Y = 0.0009414 * X + 1.629$	0.877
	All Inputs	-0.02218 to 0.03808	0.01918	$Y = 0.007949 * X + 2.683$	0.584

Appendix F

Inter-rater Reliability Results for Coded Data

Site	Entries (no.)	Entries Scored (%)	Reliability (%)
BWHI	122	79 (64.8)	79.8%
AAFPP	369	78 (21.1)	100.0%
16th Street	104	81 (77.8)	92.6%

Appendix G



IRB OVERSIGHT NOT REQUIRED

February 16, 2018

Alexandria Darden
acdarden@ku.edu

Dear Alexandria Darden:

On 2/16/2018, the IRB reviewed the following submission:

Type of Review:	Initial Study
Title of Study:	Examining Community Systems Change Implementation Effects on Intensity Scores
Investigator:	Alexandria Darden
IRB ID:	STUDY00142027
Funding:	None
Grant ID:	None
Documents Reviewed:	• Examining CSC Intensity IRB

After reviewing your application, the project described does not meet the criteria of activities subject to federal regulations at 45 CFR 46. Based on the materials submitted, it has been determined that IRB oversight is not required at this time. Though IRB oversight is not required, all activities proposed in the submission should be conducted in a responsible and ethical manner, and held to standards required by your field of study and your responsibilities as a researcher affiliated with the University of Kansas.

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are being considered and there are questions about whether IRB review is needed, please submit a study modification to the IRB for a determination. You can create a modification by clicking **Create Modification / CR** within the study.

Sincerely,

Jocelyn Isley, MS, CIP
IRB Administrator, KU Lawrence Campus