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PROJECT SUMMARY

Background. Through application of existing knowledge, much of the cancer burden is preventable. State-level practitioners are in ideal positions to affect programs and policies related to cancer control. Yet sparse knowledge exists regarding effective approaches for dissemination of evidence-based programs and policies (EBPPs) among practice audiences. There is a need to apply theory and organizational change approaches from outside of the health sector.

Goal. Our primary goal is to increase the dissemination of EBPPs to control cancer, focusing on the uptake of effective approaches among state-level practitioners.

Methods. To advance dissemination science, our project applies state-of-the-art methods in the dissemination of EBPPs among cancer control practitioners in public health departments. Cancer control practitioners are people who direct and implement population-based intervention programs in agencies or in community-based coalitions. We will make use of Diffusion of Innovations, supplemented by Institutional Theory, to inform our conceptual framework, dissemination activities, and measures. Institutional Theory uses an interdisciplinary approach to understand how social, governmental, political, cultural, and commercial institutions influence decision-making. This project includes two overlapping phases. In Phase 1, we will develop, refine and finalize measures (both self-reported and objective) to assess the effectiveness of our dissemination activities to facilitate uptake of EBPPs. Phase 2 uses a group-randomized effectiveness trial to evaluate the active dissemination of already proven EBPPs in 14 states (7 intervention, 7 control). The active dissemination activities include: conducting dissemination workshops, fostering institutional changes, and using knowledge brokers. Throughout the grant cycle, we will engage practitioners as partners to assure our approaches are timely and relevant for real world settings.

Dissemination and innovations. We will conduct several activities to ensure that tools and interventions from our grant are useful, relevant, and ready for widespread dissemination when funding ends. To prepare for dissemination, we will assemble and work with an advisory group, capture project costs, and conduct qualitative case studies. Our results are likely to impact the field by enhancing abilities to: 1) conduct active dissemination in public health practice settings, 2) speed up the translation of cancer prevention knowledge into public health practice, and 3) measure dissemination of EBPPs. This research is innovative by working in real world settings on a multi-state scale, applying new theory from outside of health (Institutional Theory), and using social network analysis to better understand the flow of knowledge.

PROJECT NARRATIVE

This project is relevant to public health because it addresses EBPPs that can result in population-level reductions in premature cancer morbidity and mortality. Sparse knowledge exists regarding effective approaches for dissemination of research-tested interventions among real world public health audiences. Upon completion, our study will provide public health practice-relevant dissemination strategies that can be adapted to other settings and risk factors.

1. SPECIFIC AIMS

Through application of existing knowledge, much of the cancer burden is preventable.[11, 12] State-level practitioners are in ideal positions to affect programs and policies related to cancer control. Yet sparse knowledge exists regarding effective approaches for dissemination of research-tested interventions among practice audiences.[13-16] This proposal seeks to reduce the burden of cancer by increasing adoption of evidence-based programs and policies (EBPPs) among public health practitioners and their partners to improve the effectiveness of cancer control. Cancer control practitioners are people who direct and implement population-based intervention programs in agencies or in community-based coalitions (described in detail in section C.5.). Many cancer control practitioners are unaware of research-tested interventions, lack the needed skills to adapt and use them, or face institutional barriers to use of EBPPs.[10, 17-20]

The proposed project applies state-of-the-art methods in the dissemination of EBPPs among cancer control practitioners in public health departments. This project includes two overlapping phases. In Phase 1, we will refine and finalize measures to assess the effectiveness of dissemination of EBPPs. Phase 2 uses a group-randomized effectiveness trial to evaluate the active dissemination of already proven EBPPs in *14 states (7 intervention, 7 control*). The active dissemination activities include: conducting dissemination workshops, fostering institutional changes, and using knowledge brokers (i.e., a masters-trained individual available for technical assistance). This study is **significant** by addressing cancer risk factors with high burden, where intervention knowledge on EBPPs is substantial, yet not commonly applied, and where a large reduction in cancer mortality is feasible if this knowledge was more widely taken up into practice and policy.[21, 22] It builds on our research team's **extensive experience** in 1) developing state-level partnerships, 2) training practitioners in use of EBPPs, and 3) conducting dissemination research studies that inform the current proposal. *This research is **innovative** by working in real world settings, augmenting Diffusion of Innovations theory with a theory from outside of health (Institutional Theory), developing new dissemination measures,* and using social network analysis to better understand the flow of knowledge. Our results will **impact** the field by enhancing abilities to: 1) conduct active dissemination in practice settings, 2) speed up the translation of cancer prevention knowledge into practice, and 3) measure dissemination of EBPPs.

Our primary goal is to increase the dissemination of EBPPs to control cancer, focusing on the uptake of effective approaches among state-level practitioners.

Specific Aim 1: Develop and test self-reported and objective approaches for assessing the dissemination of evidence-based interventions to control cancer in public health settings.

Rationale: Our recent work shows not only that there are sequential stages to dissemination but also that they can be accurately measured.[20, 23, 24] Yet these stages do not adequately take into account institutional and policy-related factors. Also lacking are objective measures of adoption of evidence-based practices.

Research Questions:

1.1: In which ways can dissemination stages and institutional factors be measured reliably through self-report?

1.2: In which ways can dissemination attributes (e.g., adoption of EBPPs) be measured reliably through objective methods (record audits)?

Specific Aim 2: Evaluate the effectiveness of active dissemination methods designed to increase the uptake of EBPPs to control cancer among public health practitioners.

Rationale: Despite extensive pilot work and smaller scale studies,[8, 10, 25] there has not been a large-scale study of active dissemination approaches for cancer control among public health practitioners in the United States.

Hypotheses:

2.1: Active dissemination activities will be associated with higher rates of awareness, adoption, implementation, and maintenance of EBPPs.

2.2: (Interaction effect) Associations will be modified by institutional (presence of incentives, high turnover) and individual-level (training in key public health disciplines) factors.

2.3: States with higher dissemination rates will have more dense and less centralized social networks than states with lower dissemination rates.

2.4: Data on project costs will show that the dissemination activities are feasible for the budgets of most state-level public health agencies.

2. RESEARCH STRATEGY

A. Significance

Cancer is the leading cause of death among persons under the age of 85, and the second leading cause of death overall in the United States. In 2010, it accounted for an overall cost of over $260 billion.[26] A range of factors is associated with the prevention and early detection of cancer, including behaviors (e.g., physical activity, healthy eating) and use of screening tests (e.g., mammography).[27] To address this burden, there is increasing attention on the effectiveness and reach of EBPPs that can be implemented at state and local levels.[28-31] *Drawing from authoritative sources,[31-34] an extensive array of effective interventions now exists to prevent cancer (**Table 1**).* Given the thousands of epidemiologic studies on the causes of cancer, now is the time to place a greater emphasis on applying this knowledge.[29] Using different methods, the estimates of Willett et al.[22] and Byers et al.[21] both suggest that about a one-third reduction in cancer mortality is feasible with the concerted application of current intervention research knowledge (with the associated decreases in health care costs).

Table 1. Interventions to prevent and control cancer

Risk factor	*Effective Interventions (examples)*	*Source (systematic review)*
Physical Activity	- Community-wide campaigns - Access to facilities - Urban planning & policy, street-scale - School-based physical education - Point of decision prompts	-Community Guide -health-evidence.ca - NCI Research-Tested Intervention Programs
Healthy Eating	- Access to healthy ready to eat foods - Food pricing and incentives - Nutrition labeling and information	-Community Guide -health-evidence.ca - NCI Research-Tested Intervention Programs
Tobacco Use Prevention	- Clean indoor air - Taxes and pricing - Media campaigns with interventions - Product warning labels - Reducing patient costs for treatment	-Community Guide -The Cochrane Public Health Group - NCI Research-Tested Intervention Programs
Skin cancer prevention	- Educational/policy interventions in primary schools - Educational/policy interventions in recreational and tourism settings	-Community Guide -The Cochrane Public Health Group - NCI Research-Tested Intervention Programs
Cancer screening (breast, cervical, colorectal cancer)	- Multi-component approach using media, education, and enhanced access - Removing structural barriers - Client incentives with reminders - Reducing client costs	-Community Guide -The Cochrane Public Health Group - NCI Research-Tested Intervention Programs

A.1. Importance of dissemination research. University-based research yields a growing supply of new discoveries, and practitioners, payers and consumers are eager to benefit from science. But research findings often take 15-20 years before being incorporated into practice. [35-37] Over the past few decades, several attempts have been made to take a more evidence-based approach to the development and use of clinical practice guidelines, including those focused on cancer prevention.[38] Efforts such as Cancer Control P.L.A.N.E.T. and the Community Guide have begun to put evidence-based tools in the hands of cancer control practitioners.[19, 31, 39] These tools are important for several key reasons: 1) cancer control practitioners and policy makers value scientific knowledge as a basis for decision-making;[13, 40] 2) the scientific literature on a given topic is often vast, uneven in quality, and inaccessible to busy practitioners; and 3) tools such as Cancer Control P.L.A.N.E.T. provide a systematic approach to planning, implementing, and evaluating EBPPs.[40] Our recent work suggests that while awareness of the Community Guide is fairly high in state health agencies, the implementation of the EBPPs in the Guide varies widely and is limited in many states.[20] Similarly, Hannon et al. found that while cancer control practitioners showed a strong preference for cancer control programs that have been shown to work, less than half of respondents (48%) had ever used EBPP resources.[41] A recent national survey of state practitioners in chronic disease control found only 20% often use EBPPs in their work.[42] The need for more effective dissemination and application of cancer research discoveries is a major theme in NCI's Strategic Plan (Strategies 2.6, 3.8, 5.6, 6.1, 6.5, and 7.4).[43]

A.2. Individual and contextual barriers to dissemination. The gap between research and practice underscores the need to understand the barriers to dissemination and uptake. Several studies (*including our previous research*) have reported public health practitioners' personal and institutional barriers to utilizing EBPPs. Lack of time, inadequate funding, and absence of cultural and managerial support are among the most commonly cited barriers.[7, 10, 44-46] In a recent national survey of public health practitioners, absence of incentives within the organization was the largest barrier to evidence-based decision making.[10] Other studies have found a strong correlation between the perception of institutional priority for evidence-based practices and actual use of research to inform program adoption and implementation.[20, 44] Therefore, it is important to recognize that dissemination is not likely to succeed in an environment that is not supportive of evidence-based approaches.[47] At an individual level, US public health practitioners who lacked skills to develop evidence-based programs were likely to have a lower level of education, suggesting that some personal barriers are modifiable through training.[10] To overcome barriers, key elements of dissemination research are to identify priorities and to involve the target population (practitioners).[47-49]

A.3. Promising dissemination approaches and audiences. There is a pressing need for sound research on dissemination of effective interventions to control cancer.[48] In various efforts to disseminate practice guidelines using passive methods (e.g., publication of consensus statements, mass mailings), adoption has been

relatively low, resulting in only small changes in the uptake of a new practice.[15] *While there has been a considerable number of implementation research studies in relatively narrow settings (e.g., a primary care clinic), there has been sparse, large-scale dissemination research.* Our team recently conducted a systematic review of dissemination and implementation (D&I) studies to address cancer prevention in community settings.[16] In our review of 25 unique studies, most research used active D&I approaches and multi-modal D&I strategies. Further, the role of organizational (institutional) factors in the D&I of evidence-based interventions was scarcely examined in the included studies. Two other recent dissemination studies from our team provide a foundation for the dissemination activities in the current proposal. In a study of the dissemination of physical activity guidelines in state and local health departments, our team found that brief workshops for state health practitioners can enhance skills and actions to apply EBPPs that promote physical activity.[23] In a randomized trial among public health practitioners in Canada, Dobbins and colleagues found that targeted messages may be an important strategy for enhancing the use of scientific evidence to promote healthy body weight.[25] The team also found that organizational factors (e.g., value of research evidence) moderated the primary outcome.

Substantial potential for research on dissemination of EBPPs to control cancer exists at the state level. Under the constitutional doctrine of reserved powers, the fifty states retain primary authority to protect the public's health.[50] The states shoulder their broad public health responsibilities largely through work carried out by state health agencies.[51] Practitioners in state health departments are in unique positions to affect the uptake of EBPPs.[52] This is due to their ability to assess a public health problem, develop an appropriate program or policy, and assure that programs and policies are effectively delivered and implemented.[53] The scientific literature helps in assessing priority areas for cancer control in public health practice. Based on the experience within state health departments, Meissner and colleagues[54] summarized factors contributing to success in controlling cancer in the public health setting. Key factors include: 1) commitment of the organization's leadership to cancer control; 2) existence of appropriate data to monitor and evaluate programs; 3) appropriately trained staff; 4) the ability to obtain funds for future activities; 5) access to outside health experts; and 6) diffusion of initially successful programs to other sites. This proposal addresses all of these factors. For dissemination of EBPPs to control cancer, our primary audience is cancer control practitioners (described in detail in section C.5.), who are responsible for developing, implementing, and evaluating programs and policies.[55-57]

A.4. Summary of background and literature gaps. The proposed project is timely and important because: 1) existing EBPPs known to prevent cancer are not being widely applied despite their potential impact; 2) research on barriers suggests potential leverage points; and 3) state-level cancer control practitioners are in ideal positions to lead intervention efforts. The project will draw on these data, resources and opportunities to test and identify alternative, active, and more effective methods of disseminating EBPPs.

B. Innovation

The proposed project is innovative on several levels. First, the measures for dissemination among cancer control practitioners are vastly under-developed.[16, 48, 58] Our study will be among the first to develop and utilize reliable and valid measures of dissemination that are currently lacking. *For example, although medical record audits are commonly used,[59, 60] we found no studies that have developed reliable methods for auditing public health records.* Second, while some dissemination lessons have been learned in Canada and from non-health disciplines (e.g., use of knowledge brokers),[25, 61] many of these have not been applied in the United States. *Third, Diffusion Theory is the most widely used theory in dissemination research,[62, 63] yet theories and models from other fields are not well applied. Our study will be among the first to augment Diffusion of Innovations theory with constructs and measures from Institutional Theory (primarily from the fields of economics and political science) among public health settings. Fourth, the use of social network analysis is relatively new for dissemination science and has high potential to elucidate key relationships and methods of evidence diffusion (e.g., centralized versus de-centralized networks).* And finally and perhaps most importantly, too often researchers have used the "push" model where new science is generated and pushed out to practice settings,[14, 64, 65] assuming that adoption will occur regardless of fit. Our study uses a participatory, flexible "menu" approach, from which to select a set of dissemination activities that have the greatest salience and feasibility among the states enrolled in our dissemination trial in the 2nd project phase. A project on the scale proposed has the potential to begin to shift the paradigm on how research can be more effectively be disseminated across the United States to those in the best position to use the evidence (public health practitioners).

C. Approach

C.1. Overview. This is a multi-part dissemination study that consists of two overlapping and complementary phases. While our study contains elements of both dissemination and implementation research, we deem this a dissemination study because it involves targeted distribution of knowledge of evidence-based interventions to

public health practice audiences.[66, 67] Phase 1 focuses on development of dissemination measures (both self-reported and objective). The second phase implements a set of active dissemination strategies in *seven* states via a group-randomized design.

C.2. Pilot work specific to the current proposal. *Our team has conducted extensive pilot work to support the current proposal.* To highlight this preliminary research, four inter-related projects are described *(also see Appendix A).*

C.2.a. Training in evidence-based public health to control cancer. In 1997, the Evidence-Based Public Health course was developed by Brownson and colleagues.[45, 68-71] Through extensive partnerships, this training program has been offered 19 times in Missouri, 10 times nationally, and 9 times internationally. Attendees (total n = 1,150) have been mid- to senior-level program managers without extensive training in epidemiology or biostatistics. A book based largely on the course (Oxford University Press) is now in its second edition.[72] This course is acknowledged internationally as highly beneficial to practitioners, described as "NACDD's acclaimed training program…"[73] and featured in an article highlighting the most innovative training programs developed and delivered by CDC's Prevention Research Centers.[74] It follows key principles of adult learning, which were recently articulated by our team.[75] To date, there has not been a version of the course designed specifically for practitioners in cancer control even though we have developed cancer-specific competencies.[76]

C.2.b. Understanding dissemination of physical activity guidelines. This project's primary goal is to assess the dissemination and uses of the Community Guide among state and local public health practitioners. In assessing use of evidence-based interventions in this project, a survey was conducted among 49 state public health leaders, with a 94% response rate.[20] In addition, local health department leaders (n = 105) were surveyed with a 73% response rate. Several key factors predicted adoption of EBPPs at the state level, including: the presence of state funding, whether the respondent participated in moderate physical activity, and whether new programs were developed based on the Community Guide.[20] *A follow-up survey demonstrated that short, interactive workshops show promise in enhancing the uptake of EBPPs*.[23]

C.2.c. Understanding barriers to evidence-based decision-making. In our recent nationwide survey of state-level chronic disease practitioners (conducted with NACDD), participants indicated the extent to which they agreed with statements reflecting four personal and five organizational barriers to evidence-based decision making.[10] Overall, survey participants (n = 447; response rate = 65%) reported higher scores for organizational barriers than for personal barriers. Participants found the largest barriers to implementing EBPPs as lack of incentives and unsupportive organizational culture. *These data suggest the need to address organizational barriers to evidence-based decision making (as we do in this proposal by use of Institutional Theory).*

C.2.d. Exploring knowledge translation in public health settings. A group randomized trial was conducted among a national sample of Canadian public health departments. Three interventions to enhance dissemination of EBPPs included access to an online registry of research evidence; tailored messaging; and a knowledge broker. The primary outcome assessed the extent to which research evidence was used in a recent program decision, and the secondary outcome measured the change in the sum of evidence-informed healthy body weight promotion policies or programs being delivered at health departments. The results of this study suggest that under certain conditions tailored, targeted messages are more effective than knowledge brokering and access to an online registry of research evidence. Greater emphasis on the identification of organizational factors is needed in order to implement strategies that best meet the needs of individual organizations.

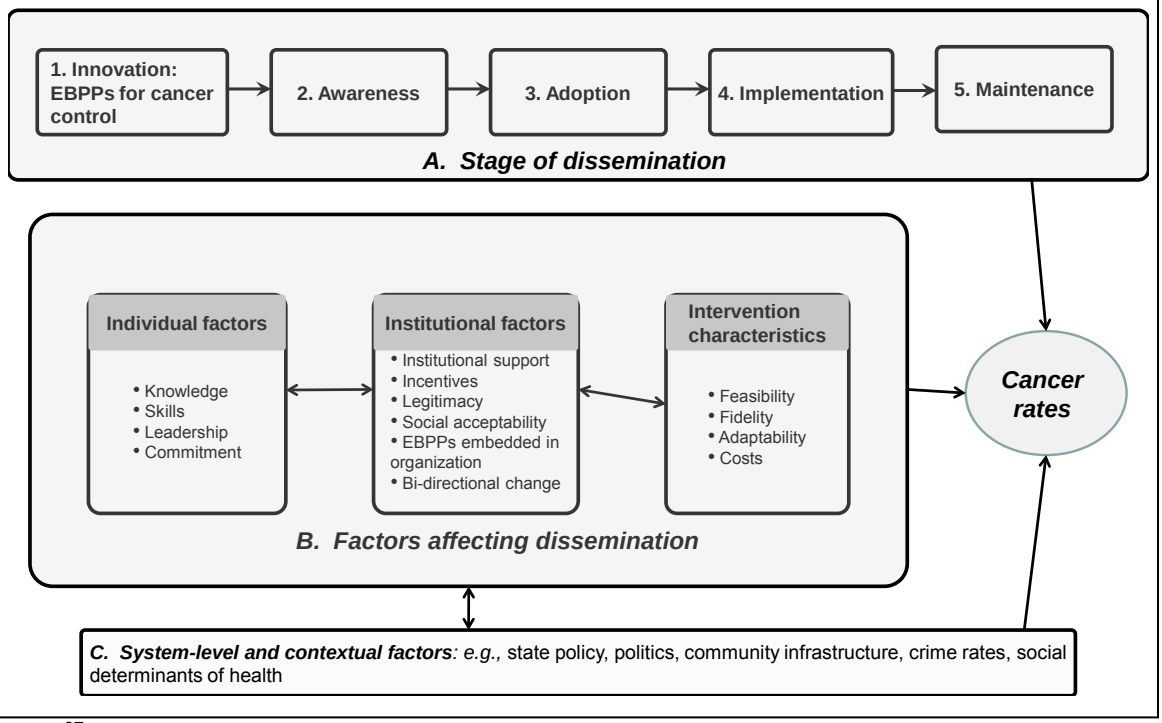
C.2.e. Summary. In conclusion, our preliminary work demonstrates our ability to 1) utilize existing and develop new national and state-level partnerships to carry out dissemination research, 2) recruit practitioners into our studies with high response rates, 3) train practitioners on use of EBPPs, and 4) conduct large-scale dissemination research.

C.3. Expertise of research team members. *Our strong, trans-disciplinary team includes international leaders in dissemination research and is highly-qualified to conduct the proposed study, building on years of collaborative research among team members.*[13, 16, 58, 68, 77-80] **Ross Brownson, PhD** (Prof. of epidemiology at Washington University) has a background in chronic disease and applied epidemiology[81] and brings extensive experience to the project in the design, implementation, and evaluation of interventions to prevent cancer,[82-90] implementation of large population-based surveys,[91, 92] dissemination research,[20, 23, 58, 67, 93] and translation of science into public health practice in the US and other parts of the world.[13, 68, 69, 93-95] **Elizabeth Baker, PhD, MPH** (Prof. at Saint Louis University) brings experience in using community-based research approaches to ensure that new programs take into account the context and needs of the target population.[96-99] **Katherine Stamatakis, PhD, MPH** (Asst. Prof. at Washington University) has a background in social epidemiology and currently holds a career award to understand obesity prevention in local health agencies.[6, 100] **Timothy McBride,**

PhD (Prof. and health economist at Washington University) will provide expertise in Institutional Theory and cost analysis.[13, 101-105] **Jenine Harris, PhD** (Asst. Prof. at Washington University) brings expertise on the use of social network analysis across public health topics and settings.[106-108] **Yan Yan, MD, PhD** (Assoc. Prof. at Washington University) brings expertise on biostatistical methods and analyses.[109-112] We will involve two consultants: **Maureen Dobbins, PhD** (Assoc. Prof. at McMaster University) and **Jon Kerner, PhD** (senior scientific advisor at the Canadian Partnership Against Cancer) who both bring substantial experience in dissemination research and research dissemination.[14, 25, 40, 44, 61, 113] A key partner in this project is the **National Association of Chronic Disease Directors** (NACDD) (letter from Mr. Robitscher in Appendix D *describes the NACDD role*). The NACDD is the only national public health association that represents chronic disease program directors in each state and US territories to reduce the impact of chronic diseases (58 voting members, 1,500 regular members).[114] We also will work closely with the Division of Cancer Prevention and Control at the Centers for Disease Control and Prevention (CDC) (letter from Dr. Plescia in Appendix D).

C.4. Conceptual framework. *The theoretical basis for our study and measures is the Diffusion of Innovation theory,[63] supplemented by Institutional Theory.[115-117]* We have successfully developed and applied staged theory in earlier work.[23, 24, 58, 93] In the context of this proposal, EBPPs are the innovations—defined as the idea, practice, or object that is perceived as new.[63] The decision to adopt, to accept, and to utilize an innovation is not an instantaneous act, but a process.[63] We define dissemination as the process of putting to use or integrating EBPPs within a target population (state-level practitioners).[67] Our dissemination framework is shown in **Figure 1.** Each stage of our framework has specific characteristics. In the innovation development phase, members from the target audience provide critical feedback on product development, production, and design of materials. The awareness stage defines the actions taken to make target audiences aware of the innovative programs across sites and settings.[118, 119] Active approaches that provide the information to the individual and assist them in developing the skills to use evidence (e.g., personal presentations) are more expensive, but necessary to achieve broad reach.[120, 121] Adoption can be defined as "a decision to make full use of an innovation as the best course of action available."[63] The adoption phase examines factors that influence the decision to undertake the innovation by an individual or organization.[119] Implementation can be defined as the extent to which an innovation is carried out with completeness and fidelity. Maintenance refers to the extent to which an innovation, such as a program, becomes embedded into the normal operation of an organization.[122]

Figure 1. Factors affecting the stages of dissemination of EBPPs to control cancer



For an intervention to become institutionalized within an organization it has to become part of the standard operating procedures,[123] often resulting in adaptation of the innovation by the host institution. As shown in **Figure 1**, the factors affecting dissemination are hypothesized to fall into three categories. Individual factors can reflect the skills, knowledge, leadership or commitment of the individuals involved in the dissemination. We will draw on the contributions of Institutional Theory,[115, 116, 124-126] mainly used in disciplines outside of health, to inform our conceptual framework about dissemination processes. Institutional theory uses an approach that combines theories from a wide range of disciplines such as economics, political science, sociology and anthro-

pology to understand how social, governmental, political, cultural, and commercial institutions influence decision-making.[127] This theory teaches us that it is not just how individuals make decisions that influences outcomes (as suggested in theories like neoclassical economics), but also the "rules of the game" that govern behavior (including not only formal explicit rules such as regulations and laws) and informal, implicit rules (social norms and conventions, self-imposed codes of conduct).[128] *Several of the key constructs from Institutional Theory identified in* ***Figure 1*** *that have contributed to the conceptual framework, dissemination activities, and measures are: 1) institutional support for EBPPs, 2) incentives and motivation for employees to utilize EBPPs, 3) embedding EBPPs in an organization, 4) legitimacy and social acceptability of EBPPs, and 4) bi-directionality of institutional change (i.e., organizations influence employees and the reverse).*[128-130] The factors hypothesized to influence dissemination also includes intervention characteristics (e.g., feasibility, adaptability, costs). *These constructs are addressed in our menu of interventions (section C.9.4.) and in our evaluation plan (section C.9.5.).*

C.5. Target audience: state-level practitioners and related partners. Cancer control practitioners are people who direct and implement population-based intervention programs in agencies or in community-based coalitions. These practitioners may be directly involved in program delivery or may set priorities or allocate resources for programs related to cancer risk factors (**Table 1**). We anticipate the target audience will be interdisciplinary; that is, they will be drawn from diverse backgrounds including health educators, epidemiologists, community health nurses, or persons with business backgrounds. Examples of the individuals in our target audience include: 1) the director of the CDC-funded comprehensive cancer program for the state; 2) a leader in a state or regional cancer control coalition; 3) the director of chronic disease prevention programs for a city health department; 4) the director of a community-based agency with interest in cancer control; or 5) the local program head for the Susan G. Komen Foundation.

C.6. Recruitment of participants and sites. Participants will be drawn across the United States from the 1,500 person membership of NACDD. We have worked successfully with NACCD on several previous projects.[10, 45, 68, 71, 131] In Phase 1, we will recruit 400 individuals. In Phase 2, 7 intervention and 7 control states will be randomly selected and recruited (see section C.9.1.). *For the 7 intervention states, we will work with NACDD to include an array of partners in addition to state health department participants: local health agencies, coalitions, voluntary health agencies, and health care systems. The Phase 2 sample size is 756 (average of 54 per state X 14 states) (see power calculations in section C.9.2.; there will be no overlap between the samples).* From previous projects, we have had extensive experience in contacting, enrolling, and interviewing a wide range of practitioners and policy makers. In our studies of physical activity dissemination and state-level child obesity laws,[8, 20, 23, 132, 133] we had over a 90% response rate when interviewing legislators, their staffers, and health department officials. In a recent, national survey of NACDD members, we achieved a 65% response rate.[10] Our recruiting techniques will follow state-of-the-art (mixed) methods,[134, 135] including a combination of regular mail, email, telephone contact, and endorsement from NACDD leadership and officials in the states where we will enroll participants.

C.7. Planning by engagement of advisors. A key principle of our project involves partner engagement, where the literature suggests that involvement of key stakeholders in designing, implementing, and evaluating projects leads to more relevant and effective approaches.[136-140] *We will assemble an Advisory Group for our project with the charge to provide: 1) overall guidance on the project; 2) review of survey methods and instruments; 3) input on the "menu" of dissemination interventions (listed in section C.9.4.); 4) guidance on the evaluation design; and 5) assistance in disseminating our findings. We have developed this proposal with input and support from partners with NACDD and CDC and will continue to obtain their input on the approaches used throughout the project. Our Advisory Group will include five members of our research team and seven practitioners (from our intervention states, once they are selected).* We have a strong track record of such stakeholder involvement in numerous earlier studies.[7, 85-87, 97, 131, 141-144] The Advisory Group will interact regularly by email and will meet monthly via conference call beginning in year 1 and bi-monthly in years 2-5.

C.8. Phase 1, validating measures (Aim 1). The measures to assess the dissemination of EBPPs for cancer prevention are under-developed.[16, 48, 58] Therefore, Phase 1 will focus on finalizing measures (both self-reported and objective).

C.8.1. Self-reported measures. To collect self-reported endpoints, we will develop a Dissemination Survey for Cancer Control (DISCC) based on previous work,[10, 20, 23, 25, 58] input from our Advisory Group, cognitive testing, and factor analysis. Our survey tool will cover four main domains: 1) biographical information; 2) ratings on importance and current level of proficiency for a key set of 10-20 competencies essential for implementing EBPPs;[76] 3) Likert-scaled variables that can be summed for an overall measure for each stage of dissemination (***Figure 1, rectangle A***); and 4) a set of institutional factors that are likely to affect adoption (***Figure 1, rec-***

tangle B) (questions 74-84 in Appendix E). Several processes will be used to develop reliable measures for the DISCC. New measures will undergo expert review for content validity, relying on our Advisory Group. Before our instrument goes into the field, a series of individual interviews will be done for cognitive response testing of the newly developed items. Cognitive response testing is routinely used in refining questionnaires to improve the quality of data collection.[145-147] Cognitive response testing is used to determine: 1) question comprehension (What does the respondent think the question is asking?); 2) information retrieval (What information does the respondent need to recall from memory in order to answer the question?); and 3) decision processing (How do they choose their answer?). People chosen for this phase will include persons in the same target group as Phase 2 but who will not participate in Phase 2. Approximately 10 individual interviews will be conducted. Interview participants will receive a reimbursement gift card of $20 value. We will use information from these interviews to modify items and formulate the final questionnaire for administration. The main statistical tool will be confirmatory factor analysis within an explanatory framework using structural equation models.[148, 149] By using factor analysis, we will seek to reduce the relatively large number of items in the DISCC to a smaller number of underlying latent variables.[150] Using methods developed for a recent dissemination study of physical activity guidelines,[151] our questionnaires will undergo reliability testing. Using a 7- to 10-day window between the 1st and 2nd interview, 100 individuals from our target audience will complete the DISCC twice to examine test-retest properties. Based on these results, questions with concordance less than 0.70 will be revised. We have extensive experience in developing and testing survey tools relevant to this study.[91, 152-155]

The sample (n = 400) for the development of self-reported measures will be drawn from the membership of NACDD (n = 1,500). We will not include Phase 1 respondents from states selected for Phase 2 to minimize burden on respondents, allowing us to draw from 36 states in Phase 1. For the factor analysis, given a minimum of three items per factor and expected factor loading of .4 or higher, we need a sample of 400 (likely a conservative estimate given that most factors will be comprised of >3 items).[156] For reliability testing, for statistically significant ($p < 0.05$) Kappa values of 0.50 and 0.70, the sample size requirements are 50 and 25 pairs, respectively, in each of two groups. To estimate a correlation coefficient (r) of 0.90 or above (power 0.80, $p < 0.05$), 45 pairs are required in each subgroup. Sample size estimates are based on Dunn's recommendations.[157] Therefore, a sample of 100 (a sub-sample of the 400) for reliability testing will provide high power.

C.8.2. Objective measures via record review. To supplement the self-reported data, we also will document the feasibility of collecting objective data for selected variables by abstraction from public health documents. The collection of objective measures is analogous to the medical record audit, which is a "gold standard" in health services research.[158, 159] *A review and abstraction of state-level cancer control public health records has been pilot tested in three states. In this work, we analyzed 23 documents and found inter-rater reliability of 86% (Appendix C). Twenty-three EBPPs were identified in the pilot. We will only review government records since these are open to public access and readily available.* While it is unlikely that we will find all relevant records, many state programs are CDC-supported categorical programs. For these, there has been considerable movement toward standardization in reporting from CDC, HHS, OMB, and others. This will increase our likelihood of retrieving relevant information. In Phase 1, a detailed code book will be developed and tested in the same 36 states as the self-reported measures. *In addition, data will be collected for two years from all 14 states in Phase 2. These data then become baseline data for the Phase 2 dissemination study.*

Step 1: Identifying relevant records. Relevant state-level chronic disease prevention and control program records will be identified within the selected states from various sources, state health agency websites, progress reports to the CDC, and websites of the state legislatures. We will begin by using NACDD records to identify state-level programs and partners in cancer control. *Our search will focus mainly on state health department records. However, in many instances, the states fund local entities (e.g., county health departments) to implement cancer control activities. Therefore, we will also seek relevant records at the local level when state or federal funding is present. These records include annual reports, workplans, and strategic plans.*

Step 2: Data abstraction. Data collected via record review and abstraction are subject to bias that may result from rater subjectivity.[60] Cancer control records will be reviewed and data will be abstracted by two trained evaluators using standardized methods and a data collection tool created by the research team (see draft in Appendix B). The development and use of a standardized instrument for the review and abstraction will improve inter-rater reliability and will provide quantitative data for monitoring trends and intervention effects. Examples of variables of interest include: number of grant proposals submitted featuring EBPPs, EBPPs in performance appraisals, and EBPPs called for in contracts let (e.g., with local health agencies). The two raters will extract data independently and come to consensus. *To our knowledge, ours is the first study to compare self-reported dissemination data with the objective information described above. For key variables (e.g., use of EBPPs) we will compare data from the DISCC with those obtained by record review. For example, if a state*

*respondent reports using EBPPs from the Community Guide in the DISCC, objectively abstracted data can examine whether this use of EBPPs is apparent in program records. The validation of the self-reported DISCC measures and objective audit data will inform primarily stages 4 (implementation) and 5 (maintenance) of our staged dissemination model (see **Figure 1** and **Table 2**).*

C.9. Phase 2, group-randomized trial (Aim 2). *Phase 2 is a paired, group-randomized study of dissemination of EBPPs that are already proven to be effective in controlling cancer and recommended by leading national authoritative bodies.*[31-34] In year 2 of the project, we will begin active dissemination efforts in selected states. Our target audience for Phase 2 is mid- to senior-level cancer control practitioners (see section C.5.). These individuals are likely to have resources at their disposal, will have linkages with key stakeholders, and are in a position to affect change.[76] The proposed dissemination phase will implement strategies designed to enhance and evaluate awareness, adoption, implementation, and maintenance of the EBPPs. The four main sources for EBPPs are those in the right-hand column of **Table 1**.[31-34] *Seven* states will be randomized to the intervention condition and *seven* will serve as controls. The intervention seeks to build capacity and to effectively package information so that is it timely, relevant, and useful for various state-level practitioners. Our approach addresses important threats to internal validity including the need for a conceptual framework, random allocation, assuring the highest possible validity and reliability of measures, assessing potential mediators and moderators, and the need to control for the effect of secular trends in dissemination outcomes.[160-164] Data collection methods developed in Phase 1 (self-reported DISCC tool, objective measures) will be used on Phase 2.

C.9.1. Study population and selection of states. *We will recruit participants for Phase 2 from 14 randomly selected states (7 intervention, 7 control). These will be pair matched by size of the state health department, geographic region, amount of CDC funding in cancer control, and centrality of state and local public health governance.*[165] *Randomization will occur after pair matching as in previous large community trials.*[166, 167] *Based on NACDD records, there is an average of 40 cancer control practitioners in each state who work in the state health department. Our intervention activities (section C.9.4.) and evaluation will occur not only at the state level. In each of the 14 states, we will also gather data on other contextual state-wide entities (e.g., a state cancer control coalition) and local-level activities (e.g., local health agencies active in cancer control). It is worth noting that in nearly 30% states, the state health department delivers all local public health services and in the remaining group, local agencies obtain a significant amount of their funding for chronic disease prevention from the state.*[5, 168, 169] *On average, per state we anticipate 40 individuals in state government, an additional 10 practitioners from partner (non-governmental) agencies in each state (e.g., the American Cancer Society, the Komen Foundation), and 30 at the local level. This allows us a total of 1,120 (80 X 14) individuals for recruitment into Phase 2 (from the power calculations that follow, 756 individuals are needed at baseline) (anticipated baseline response rate = 67.5%).*

C.9.2. Power calculations. This study uses a paired, group randomized design. The paired design is the most appropriate for this study since it is not feasible for us to obtain more than 14 states (clusters) in total. By using tight matching criteria, we will balance some important potential confounding state-level factors (e.g., state size, state funding in cancer control) that may affect the trial outcomes. As a result, the between-cluster variation will be reduced, resulting in a gain in the statistical power.[170, 171] Based on our preliminary studies and values of ICC in the literature,[10, 20, 23, 25, 172-174] we have estimated a range of effect sizes and ICCs. ICC estimates are the most difficult to obtain; we calculated a median ICC from similar studies and developed a range based on a 50% decrease and increase around the median (range 0.009 to 0.027). The sample size requirement is based on testing three hypotheses with a power of $\geq$90% and the overall Type I error of 5% given 7 paired clusters (states). The null hypotheses suggest there would be no change in the scores from baseline of three outcomes—awareness, adoption, and maintenance—in both the intervention and control arms (no change). Drawing from our previous work,[20, 23, 25] the corresponding three alternative hypotheses for the change in scores in the intervention arm are 17%, 20%, 14% higher than the control arm for awareness, adoption, and maintenance, respectively. *Following Donner*[175] *and Thompson,*[176] *and our previous ability to obtain high response rates,*[20, 23] *we estimate the number of subjects needed in each state is 40 at post-test and 54 at baseline (total = 756) (for our primary hypothesis 2.1) (see Appendix F). This assumes a 74% post-test response rate (.74 X 54 = 40), which is conservative given our previous work.*[20, 23]

C.9.3. Planning for the Phase 2 trial. Cancer control covers a large array of diseases, risk factors, and intervention approaches. To narrow this, prioritize, and tailor approaches to each state, we will follow a 5-step, theory-informed, prioritization process within each of the *seven* intervention states. This will allow us to prioritize areas of interest and the menu of options (section C.9.4.) that will be most useful in dissemination effort. This process is highly congruent with well-known planning models developed by ours and other teams.[72, 177-179]

Step 1: *Provide cancer and intervention data*. Tools in P.L.A.N.E.T. (e.g., CDC WONDER, BRFSS data) will allow us to analyze the cancer burden at a state or local (county) level. This will help to identify high-risk populations and prioritize efforts. We will organize data from public health surveillance systems to provide state, and where possible, county-level statistics. We will provide tables, graphs, and maps to practitioners. Cancer sites and risk factors will be highlighted for which effective methods of primary prevention/early detection are available. *Potential interventions will be organized around the domains in* ***Table 1****.*

Step 2: Rank intervention importance and feasibility. Once the data from step 1 have been compiled, we will conduct a simplified version of Concept Mapping, which we have used in numerous studies.[1-4] *In particular, the principles of concept mapping will help us to assess intervention importance and feasibility using an online survey. In part one, participants will rate each intervention idea on its importance relative to the other ideas, and on the other survey they will rate the feasibility of implementing the idea in the next 5 years (scores will range from 1, relatively unimportant/not feasible, to 10, extremely important/feasible) using a secure Web site. The data on feasibility can also be used as a controlling variable in the analyses.*

Step 3: Assess institutional and broader contextual factors affecting dissemination. *Qualitative interviews will be conducted to assess the organizational, inter-organizational and broader contextual factors that may facilitate or hinder dissemination. Within each of the seven intervention states, we will conduct key informant interviews and will begin by asking the participants general questions regarding these factors and will then probe on issues such as: the relationship of their organization's mission to health, organizational support for partnering with other organizations to create change, types of decision making structures and processes used within the organization, encouragement of new ideas and innovation, and history of relationships with the community in which the project is located (including trust) (see draft interview guide in Appendix G).* We will also assess the organization's inter-organizational partnerships and structures, including communication methods and frequency, shared resources and types of reciprocity, history of interactions between organizations (including conflict resolution strategies used), and informal versus formal relationships between organizations. *We anticipate a total of 42 interviews (an average of 6 per state).* To identify interviewees, we will begin the process of 'snowball' sampling[120] by first interviewing the lead cancer control director in each intervention state. To do so, we will explain the goals of the overall project and qualitative interviews. From there, we will identify other interviewees within the state health department or other agency. We will offer a $20 incentive for participation. The interviews will be tape recorded with participant consent and transcribed verbatim. The transcripts produced will be reviewed for completeness and accuracy. Each interview will then be coded by two coders using focused coding techniques.[180, 181] This method will use the interview guide questions to establish major categories (e.g., organizational factors, inter-organizational factors, community factors). All information that does not fit into these categories will be placed in an "other" category. In order to facilitate within and between state comparisons, data analysis may include quantification or some other form of data aggregation and reduction, including the use of data matrices, tables, and figures.[182]

Step 4: Summarize data and present to stakeholders. Once all data from steps 1-3 are summarized, we will hold a face-to-face meeting with key practitioners in each state. This will allow us to discuss the findings from the ranking process and begin to describe possible dissemination activities (section C.9.4.).

Step 5: Rank dissemination menu of activities. Among the dissemination tools available (section C.9.4.) to this project, practitioners will be asked to rate the usefulness and feasibility of each approach. This rating process allows us to tailor intervention activities in the *seven* target states to their priorities and needs. This is likely to increase the effectiveness and long term staying power of dissemination approaches. After activities are prioritized, we will work with each state to implement dissemination interventions.

C.9.4. Menu of activities to promote dissemination of EBPPs. In our experience and based on the literature,[183, 184] simply making EBPPs available for adoption is not sufficient to assure their widespread use. Therefore, active methods are needed to enhance adoption of evidence-based approaches. Five types of dissemination interventions will be offered in Phase 2. Based on the planning process described above, this section describes a menu from which state practitioners can choose intervention activities to enhance awareness and adoption of EBPPs. Our menu approach avoids the pitfalls of a "one-size-fits-all" process that is unlikely to be effective across *seven* intervention states, thus allowing us to tailor activities to the needs of each state. *However, to reduce variability within the intervention arm, states will be asked to choose a minimum of 3 and maximum of 5 activities from the menu.* Therefore, our study will not attempt to evaluate a single dissemination strategy but will pursue active, multi-modal approaches, since these are supported in the literature.[14-16, 48] *The control states will receive a minimal, usual care intervention that involves only access to EBPPs on websites such as the Community Guide,*[31] *the Cochrane Public Health Group,*[34] *Health Evidence-Canada,*[32] *and Research-Tested Intervention Programs (examples in Table 1).*[33] *The menu includes the following five activities.*

1. Knowledge brokers. Used more in Canada than in the US, a knowledge broker provides a link between research and end users (practitioners) by developing a mutual understanding of goals and cultures, collaborating with end users to identify issues and problems for which solutions are required, and enhancing access and use of research evidence in practice and policy.[61] Although the public health and health care literature is sparse with evaluations of knowledge broker impact,[185] there is considerable evidence of effectiveness in other fields, particularly from business and agricultural sectors.[186-188] Qualifications for our knowledge broker include the following: a master of public health degree, extensive knowledge of public health in the United States, some experience in research and in interpreting research results; experience in implementing EBPPs for cancer prevention, and practical experience as a public health decision maker. Activities from the knowledge broker include: 1) assistance with needs assessments and strategic planning that incorporate EBPPs in the process; 2) phone and email consultation on intervention planning; 3) help with grant writing that incorporates information from evidence based sources; and 4) participation in the dissemination workshops described below. Interaction with the broker will be one-on-one (broker to individuals and teams within the state health department) and it includes face-to-face contact, telephone, and email communication.

2. Targeted dissemination workshops. The workshops promoting the use of EBPPs will be modeled after successful workshops that have been conducted to promote evidence-based decision making (section C.2.a.),[45, 71] sessions that were held to promote the tobacco recommendations of the Community Guide,[189] and workshops to build more effective physical activity programs.[23] The five objectives for our dissemination workshops are to: 1) understand the burden of cancer risk factors in order to prioritize cancer control efforts; 2) understand the key role of EBPPs in addressing the cancer burden; 3) identify cancer control strategies recommended by evidence-based reviews (e.g., the Community Guide); 4) understand how to effectively communicate information on EBPPs to state-level practice partners and policy makers; and 5) initiate action steps to move toward implementation and evaluation of EBPPs. It is anticipated that *seven*, three-day workshops will be convened in the second and third years of the project. These will be held in the states that choose this from the menu with a maximum of 30 participants per workshop. All workshops incorporate principles of science-based training,[71, 75, 190] including: an informal learning environment, team training, experiential learning, and small group activities applicable to real world challenges. In addition, informal peer knowledge sharing shows promise in raising skills;[191] we will sponsor monthly luncheons of dissemination workshop attendees to facilitate this exchange.

3. Targeted messages. Similar to the approach successfully used in Canada,[25] we will provide targeted messages plus access to websites with data on EBPPs (e.g., the Community Guide, Cancer Control P.L.A.N.E.T.). The targeted messaging involves sending participants a series of emails that include the title of a systematic review followed by a link to the full reference, including abstracts. Over successive weeks, on the same day each week and the same time of day, participants will receive an email indicating that a systematic review related to cancer control is available. The message includes a short summary of the research and actions that might be taken based on the evidence. *The uses and usefulness of targeted messages can be measured in numerous ways by: 1) tracking the number of recipients who open the message link; 2) identifying which content areas are most popular by the frequency of opening links in specific content areas; and 3) at the post-test survey (section C.9.5.), asking about use of the messages, how they were used, and whether they passed these on to others.*

4. Institutional changes. The team will work with the *seven* intervention states to identify a range of strategies that would foster institutional change (consistent with Institutional Theory which was described in section C.4.). These will be refined in our dissemination research planning (section C.9.3.). *Examples of strategies that will be employed will seek to: identify ways agency leadership can prioritize use of EBPPs, develop incentives for use of EBPPs (e.g., attendance at national meetings), and incorporate EBPPs as a core component of agency practices (e.g., performance reviews, contracts with local partners). As examples of measures see questions 74-84 in Appendix E.*

5. Issue briefs combining statistical and narrative communication. Although effective communication is an essential part of dissemination,[64, 192, 193] public health information for leaders is not adequately targeted yet. Information that is highly research-oriented and commonly used among public health experts may not be useful to practice and policy audiences.[13, 80] Data-based approaches are used by health experts who are typically trained to summarize scientific information using empirical statistics. Narrative dissemination turns scientific data into compelling stories that show how evidence-based interventions can affect the daily lives of people. These narrative forms of communication are emerging as important tools for cancer control.[192, 194, 195] We will combine data based approaches with narrative approaches to produce issue briefs for the *seven* intervention states. An issue brief is a 1-2 page summary of a relevant cancer control issue. It often includes a catchy headline, a graph or chart that illustrates the main findings, and a small paragraph or a few bullet points on the find-

ings from the evidence-based intervention. Based on the prioritization process in section C.9.3., we will produce a series of state-specific briefs on the cancer risk factors/diseases of interest. *There are a few key audiences for the issue briefs: 1) policy makers and foundations (funders) and 2) leaders within agencies (especially those who lack a health background) who set priorities for action within an agency or state.*

C.9.5. Evaluation. Our evaluation will track intervention awareness, adoption, implementation, and maintenance (**Table 2**). We will use an adaptation of the RE-AIM framework (Reach, Efficacy/Effectiveness, Adoption, Implementation, and Maintenance), which has been used in previous framework development and literature synthesis by our team.[16, 58] The next section describes our evaluation approach in which we ensure our ability to document differences between intervention and control states. It also describes how we will assess the external validity of our study approaches and findings. There are few empirical data showing the most appropriate metrics for evaluation of dissemination efforts.[58, 196] Therefore, to evaluate Phase 2 interventions we will rely on three sources of data: 1) our DISCC instrument (pre- and post-test) (section C.8.1.), 2) review and abstraction of state-level cancer control records (see section C.8.2.), and 3) findings from the social network analysis (see below). While we anticipate that our study will impact behavioral risk factors (e.g., rates of smoking, inactivity, unhealthy eating) over a period of years or decades, the dependent variables for our dissemination study involve measures of individual and organizational awareness, adoption, implementation, and maintenance of EBPPs (overall summary, **Table 2**) and not the impact of EBPPs on behavioral risk factors per se.

Process evaluation. In addition to the two data sources described above, process evaluation data will help us both to determine reach of our dissemination efforts and to assess whether outside events affect findings (a form of quality control[197]). Our project team will develop a comprehensive list of process indicators early in the project, which can then be tracked. Examples of process measures include the amount of external funding granted to a state (e.g., from CDC) for cancer-related programming, attendance and satisfaction with workshops, monthly luncheons, and requests for technical assistance. We have extensive experience in process evaluation in previous, related studies.[71, 84, 85, 87-89, 198-201]

Social network analysis. Social network analysis is the mapping and measuring of relationships and flows between people, groups, organizations, and other knowledge processing entities.[108] The method has not been used widely in dissemination research yet has significant potential to provide both a visual and mathematical analysis of relationships (see draft tool in Appendix H). In years 2 and 5, we will conduct a network analysis in the intervention and control states. *This will allow us to examine general communication and collaboration among organizations around cancer control across the state as well as inter-organizational communication specifically related to EBPPs among the different agencies involved in disseminating EBPPs (including network changes over time). We will survey at least one individual from each of the following organizations: the state health department, approximately 30 local health departments, and approximately 10 other organizations. This will result in an approximate total network size of 41 organizations. Based on previous work,[106, 107, 202, 203] we anticipate at least a 70% response rate to the network analysis questionnaire and an average of 28 organizations per state network will allow robust examination of network structures.[204]*

Capture project costs. It is important to measure costs in order for decision makers to have an assessment of the relative expense of each dissemination activity. Therefore, project costs will be measured throughout the project. These costs will include factors such as labor costs, supplies and equipment, and travel. In order to make assessment of dissemination more feasible, total costs will be computed, then normed to a unit of analysis for more ready comparison (e.g., the unit cost for a dissemination workshop or an issue brief). Labor costs will include the value of the direct time expended by project staff on the dissemination activity plus the cost of benefits, prorated to each dissemination activity where possible with fixed costs averaged across activities otherwise. Supplies will include the costs of production described above, as well as the costs for supplies, and costs for items such as phone calls (prorated again per dissemination activity). Equipment expenditures, to the extent they are needed

Table 2. Evaluation summary

Stage of Dissemination	*Objective by Stage*	*Evaluation Tool*	*Sample Item*
1. Innovation Development[a]	To develop evidence-based strategies	--	--
2. Awareness	To increase awareness of evidence-based strategies	- Dissemination Survey for Cancer Control (DISCC)[b]	Have you heard of the evidence-based recommendations in the *Community Guide*?
3. Adoption	To enhance uptake of evidence-based interventions	- DISCC	Now is a good time to implement evidence-based programs in my health department.
4. Implementation	To demonstrate use of recommendations in chronic disease practice	- DISCC - Program record review	Listing of evidence-based interventions that have been implemented.
5. Maintenance	To facilitate ongoing implementation & continued use of evidence-based strategies	- DISCC - Program record review	My agency's staffing level is adequate for maintaining evidence-based programs.

[a]Because evidence based strategies (*e.g., Guide to Community Preventive Services*) are already developed, the Innovation Development stage is completed by the start of the project.
[b]From sample questionnaire in Appendix XX.

will be included, but care will be taken to measure whether these are variable to the activity indicated or an overhead cost. Finally, some dissemination activities require travel costs and these will be included to the extent these are directly associated with the dissemination activities.

Quantitative measures. Due to the design, target audience, and time frame for our study, long term outcomes involving disease rates or behavioral risk factors are not appropriate. These more traditional outcomes (e.g., cancer rates, physical activity rates) can be tracked over the long term using well-established surveillance systems such as the BRFSS and the national program of cancer registries. *Four dependent variables will be created to tie directly with our staged dissemination framework (**Figure 1, rectangle A**) (i.e., awareness, adoption, implementation, maintenance).* These are developed from ours[20, 23, 24] and others' previous research.[205, 206] For each dissemination stage, sample questions are shown in **Table 2** (see full suite of questions in Appendix E). *Phase 1 of this project will allow us to refine and strengthen the questions comprising the four dependent variables.* Most of the variables are Likert-scaled and can be summed for an overall measure for each stage of dissemination. *The changes in dependent variables could be affected by numerous potential confounders (e.g., policy support, state budgets). Therefore, numerous independent variables and potential confounders will be analyzed for our study. Some of these are mediators (intermediate factors that lie in the causal pathway) and moderators (factors that alter the causal effect of an independent variable) of dissemination (**Figure 1, rectangle B**).*[58, 160, 163, 196] Our Phase 1 research will identify various factors that potentially affect the uptake of EBPPs. A variety of individual-level variables can be developed based on the DISCC. These include sociodemographic characteristics (e.g., age, gender, education level), health promotion practices, job satisfaction, and individual-level knowledge about evidence-based intervention approaches. *Institutional level variables will be tied to Institutional Theory and will include the size of the agency in which the respondent works, the agency support for EBPPs (derived from the DISCC), and agency/administrator awareness of EBPPs.* Both at the individual level and institutional level, we will measure exposure to the dissemination activities in section C.9.4. to determine whether higher exposure leads to more progression across dissemination stages. At the state level, a variety of potentially relevant variables are available. These include: 1) state expenditures on chronic diseases and health behaviors from all sources; 2) percent of city/county health departments in a state with cancer control programs; 3) percent of population below poverty; 4) percent of population of non-Hispanic white race/ethnicity; 5) dominant political party of state legislature/governor between 2012-2013 (democrat/republican vs. split); and 6) political party of governor. We have identified, validated, and used many of these variables in an analysis of state childhood obesity legislation.[207-209]

Data processing and quality control. Carefully designed data processing procedures are necessary to ensure that data are accurate, consistent, and complete. The project team has developed a highly effective system to ensure that the final data set is as error-free as possible. These successful procedures will be adapted for this study, resulting in high-quality, efficient data control processes (entry, coding, cleaning). The end product will be a codebook for the instrument and thoroughly cleaned data files ready for analysis.

Data analysis. For all analyses, descriptive statistics (e.g., frequencies, central tendencies, and variabilities) and diagnostic plots (e.g., stem and leaf plots, q-q plots) will be completed on all variables. Data will be examined for outliers and tested as appropriate for normality, linearity, and homoscedasticity. Appropriate corrective strategies, such as transformations, use of robust methods, or data reduction, will be used if problems are identified. Bivariate and multivariate analysis will rely on data within and across times. These preliminary analyses are necessary to ensure high quality data and to test assumptions of the proposed models. We will also compare demographic variables between intervention and control groups to characterize the samples and identify potential differences between them. For the multivariate analyses, let Y_{ijk} be the change in dissemination stage score (e.g., average score on awareness scale) from baseline for subject k with treatment j (j=1 intervention, 0 control) in pair i(i=1…7). Let Y_{ij}-bar be the mean change in score with treatment j in pair i, and d_i=(Y_{i1}-bar – Y_{i0}-bar), the difference in the mean change between intervention and control state in pair i. In addition, let X and Z be a vector of the relevant variables at the state and individual level, respectively. For simple analyses, we will follow Donner[175] for analysis of matched-pair quantitative data. Specifically, we consider d_i as the unit of analysis, and use one-sample paired t-test to test if the mean of d_i is significantly different from 0. Weighted paired t-test (with the cluster size as weights) will be used if the cluster size varies across pairs. Non-parametric version of paired t-test will be used if the normality is questionable. We also will use the permutation test in which we compare the observed difference with the null distribution derived from the permutation procedure. For adjusted analyses, we will follow Thompson[176] to perform the individual level, covariate-adjusted analysis. Specifically, we will use all subjects to fit a linear model $E(Y_{ijk}=1)] = \alpha_{ij} + \beta Z_{ijk}$, and to obtain estimates of α_{ij} and β, then we obtain the adjusted change in score for each individual $Y_{ijk\text{-}adj} = Y_{ijk} - \beta_{\text{-}hat} (Z_{ijk}$ -Z-bar), where Z-bar is a vector of the overall mean of individual level covariates. After obtaining $Y_{ijk\text{-}adj}$ for each

individual, we will obtain the adjusted mean for each state, then the adjusted difference in mean change in a pair: $d_{i\text{-}adj}$. We then use $d_{i\text{-}adj}$ as d_i and perform simple analysis.

Although the random effect models are commonly used in cluster randomized studies to evaluate intervention effects, we use this method only as exploratory analysis due to the relatively small number of clusters (7 states in each arm). In the exploratory analysis we will analyze data without pairing, so the subcript i is dropped. The basic model for the change in score for k^{th} individual in j^{th} state is: $Y_{jk} = \alpha + \beta I_j + \gamma X_j + \eta Z_{jk} + v_j + \varepsilon_{jk}$;where I = 1 if intervention and 0 otherwise, X = a vector of state level covariates, Z = a vector of individual level covariates. The parameter α is the mean change score for an individual in the control states with X and Z at 0; v_j describes the variation of the change score between states and is modeled as a normal variable with the mean 0 and some variance; β is the intervention effect adjusting for all relevant individual variables Z and state level covariates X, whose effects on the outcome are described by a vector of η and γ respectively. This model can be expanded to test the possible heterogeneous intervention effects by using an interaction term with intervention indicator (I), and including some components of X or Z.

External validity. The field needs better measures of external validity, including generalizability.[48, 58, 210-212] Therefore, our study will directly address external validity in several ways: 1) in Phase 2, we will randomly sample states (based on pair matching); 2) also in Phase 2, we will track which EBPPs are being implemented and how closely fidelity is maintained as specific, evidence-based interventions (e.g., those from the Community Guide) are implemented across intervention states; and 3) as dissemination interventions are implemented, we will monitor a variety of process measures that may be important in replication such as: staff time needed for training, participation rates across sites, how effectively partners are involved across sites, and intervention dissemination to local levels. While it is beyond the scope of this project to conduct a formal cost-effectiveness analysis, as noted in section C.9.5., we will collect cost data (a key component of external validity).[212]

C.11. Timeline, project management, and dissemination. While our study is ambitious, our track record shows we will be able accomplish all activities on time (**Figure 2**). Based on our previous experience, monthly meetings and/or conference calls are necessary, particularly during year 1. We have also found it valuable to form ad hoc work groups. For example, in the current project, the following work groups will be needed: 1) measurement and evaluation (leader: Stamatakis); 2) refinement of prioritization process (leader: Brownson); 3) refinement of dissemination activities (leader: Brownson); 4) data management and analysis (leader: Stamatakis); and 5) publication/dissemination (leader: Brownson). Because our project takes place at multiple sites, it is essential to maintain on-going communication. Part of this includes ensuring that collaborators at all locations take part in regular conference calls and meetings.

Figure 2. Study time line

Phase/Activity	*Year 1*		*Year 2*		*Year 3*		*Year 4*		*Year 5*	
Phase 1										
Engage advisors	x	X	X	X	X	X	X	X	X	X
Enumerate/recruit participants	x	X	X							
Survey instrument development/testing		X	X							
Develop objective measures		X	X							
Phase 2										
Select/recruit states	x	X								
Conduct planning		X	X	X						
Implement dissemination activities				X	X	X	X	X		
Evaluate dissemination activities - quantitative evaluation, process evaluation, social network analysis, cost analysis				X	X	X	X	X	X	x
Data analyses, writing, presentation, publication			X	X					X	X

Because we will have core advisors from the practice world, we will have natural advocates and champions for project dissemination. Results of this project will be disseminated widely to researchers, practitioners, and policy makers. In addition to the activities noted above, dissemination will occur through presentations at national/international meetings and via peer-reviewed publications. Meetings of particular interest include those of the American Public Health Association and the NIH Annual Conference on Dissemination and Implementation Research. As data are available, we will focus on quality publications in high impact, peer-reviewed journals. It is also anticipated that findings from our study will be incorporated in teaching materials (including e-learning) for masters and doctoral students and in special institutes for researchers, practitioners, and policy makers. In addition, Dr. Brownson is associate editor of the Annual Review of Public Health and is an editorial board member with five other journals. As findings from this study are available, these peer-reviewed outlets will be important vehicles for dissemination.