Official Title: Messages about Cancer Screening

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RESEARCH STRATEGY

A. SIGNIFICANCE

Colorectal cancer (CRC) is the third most diagnosed and third most deadly cancer among men and women in the United States (US).[1] Although CRC rates have decreased over the past several years, progress in decreasing mortality has slowed down and morbidity/mortality rates of CRC in the US trail behind only lung, prostate (for men), and breast (for women) cancers.[1] In 2020, the American Cancer Society estimates that over 145,000 people will be diagnosed with CRC and over 50,000 deaths will be attributed to CRC.[1] Incidence and mortality related to CRC was most prominent among older populations (e.g., 50 years of age or older) for the past few decades, but new evidence suggests that CRC incidence has been increasing consistently for younger cohorts even as incidence and mortality have declined in older populations.[2-4]

Racial disparities exist among those affected by CRC in terms of stage of diagnosis and mortality rates. CRC incidence and death rates are higher among Black Americans than non-Hispanic White Americans.[1] While some CRC-related disparities have decreased (e.g., incidence and stage of presentation),[5] disparities continue to present in the context of CRC screening (CRCS).[6] CRCS has been identified as a major contributing factor to recent decreases in CRC incidence and mortality.[7] Thus, working to reduce CRCS disparities and increase overall screening rates continues to be an important public health goal.

CRC screening (CRCS) serves as a tool for prevention and early detection, but often receives less public attention than other cancer screening tests. There is sufficient evidence regarding the benefits of CRCS that the United States Preventive Services Task Force (USPSTF) recommends CRCS for individuals between the ages of 50 and 75.[8] The American Cancer Society recommends similar screening guidelines, with a caveat that starting noninvasive screening at 45 would have benefits.[9] Recommendations are for people to complete a stool test (e.g., fecal immunochemical test or fecal occult blood test) annually, a flexible sigmoidoscopy every five years, or a colonoscopy every 10 years. The public health goal (e.g., Healthy People 2020) for CRCS was to have screening rates reach 70.5% by this year, though estimates fall below that goal.[10] Currently, screening rates for Black Americans are lower than those of non-Hispanic White Americans.[10]

Barriers to screening for Black Americans are varied, but include lack of accurate information about screening options, as well as limited access to necessary healthcare resources. Complex individual- and system-level factors contribute to disparities in CRCS rates for Black Americans. Individual factors include limited knowledge about benefits of CRCS, low perceived personal risk, feelings of fear and anxiety about potential diagnoses, cost of CRCS, lack of interest in CRCS, concerns about invasiveness and intrusiveness, as well as low perceived risk of the disease.[11,12] System-level factors include inequalities in access to cancer screening information, limited continuity of care and lack of a physician recommendation about screening.[12] Studies also suggest that medical mistrust contributes to lower rates of CRCS among Black Americans.[11] While the factors influencing low screening adherence are complex, misinformation about risk and screening procedures are the most prominent modifiable individual-level factors influencing low screening rates.

Studies suggest that supportive and information-rich social networks, both online and offline, could improve CRCS among Black Americans. Studies have found that social support, family influence, social interaction, and social network density all contribute to increased CRCS rates among Black Americans.[13-15] Having larger social networks provides more access to information and conversation, offline or online, about a variety of topics like cancer screening.[16] People might intentionally be exposed to new information via targeted attempts at obtaining information (i.e., information seeking) or through their normal routines of reading the news, browsing online content, and talking to people in their social networks (i.e., information scanning). More social ties and social network members increases the likelihood of exposure to information via scanning, which may in turn result in a person seeking additional information. These are important to consider in the context of CRCS, as information scanning and seeking have been associated with cancer screening behaviors.[17-19]

Older Americans use online, digital media information sources more frequently each year for seeking, scanning, and sharing health information about cancer screening. Black Americans were more likely to use social network sites to seek out colorectal cancer information compared to White Americans.[20] Additionally, Black Americans who seek information are more likely than White Americans to use that health information to improve their health.[21] In addition, Black Americans appear to cast a wider net, reporting using more sources when scanning and seeking CRCS related information.[22] This growing body of evidence indicates the importance of online sources for health information seeking and scanning about CRC and CRCS, but little is known about the impact of the messages that individuals are encountering on these platforms. Prior research has focused on the topics of such messages and their overall credibility, but not the specific behaviors, attitudes, or expectations they encourage. One study of Twitter messages found, across all analyzed content on the platform (>75,000 tweets), interest and engagement with information about CRC from a variety of users, with most (~85%) Twitter information about CRC scored as credible.[23] Looking at Instagram posts about CRC, researchers discovered that content most often focused on patient support or treatment stories, though screening featured in content (15% of posts) as well.[24] Most research on social media in cancer contexts is focused on describing content without examining effects of that content and has infrequently focused on CRC or CRCS,[25] though some rigorous studies in the area examine interactivity (e.g., likes, comments, shares) with social media posts.[26] Research on the content and volume of messages White and Black Americans encounter from online health information sources is still unclear—particularly regarding any disparities that exist about what specific information is sought, scanned, or shared by Black Americans.

There is a critical need to understand which messages resonate among populations at-risk for specific diseases (e.g., CRC) and who may have concerns about engaging in early detection behaviors (e.g., CRCS) and may face disparities in exposure to (mis)information from online sources. Public health communicators have growing concerns about health misinformation on social media.[27] Evidence that misinformation spreads more widely and easily than accurate information online[28] suggests remedies may be needed to compete with such misinformation. For instance, researchers have used a text mining approach to identify misinformation about cancer screening on websites to assist health communicators to counter such messages publicly.[29] Other researchers found that gynecologic cancer misinformation appeared in about 30% of messages on the Chinese platform Weibo, with more misinformation presented about treatment than prevention.[30] That percentage mirrors work in the US on cancer information posted by parents on Facebook, where among posts including medical information, only 67% were accurate, with other posts being either inaccurate (19%) or conveying unproven treatments (14%).[31] Research considering YouTube videos and respective page content about prostate cancer found that 77% of studied video included misinformation or biased content, and that there was a negative correlation between the scientific quality of a video and engagement (e.g., views and likes).[32] Taken together, these descriptive studies suggest there is considerable misinformation present via social media, though none of the studies examined CRC or CRCS. Additionally, these descriptive studies provide insights into what information and misinformation exists in the public communication environment, but lack follow-up work to assess how people assess or intend to utilize this information in the future. So, while novel methods are being used to monitor the communication environment, the utility of these methods is falling short of making direct contributions to future communication efforts.

Combining computational methods of monitoring the public information environment with crowdsourcing methods to evaluate public communication preferences is an important next step at improving health communication in dynamic online information environments. Crowdsourcing refers to "an online, distributed problem-solving and production model that leverages the collective intelligence of online communities to serve specific organizational goals" (p. xix).[33] Crowdsourced data function as an important source of knowledge about improving public health[34] and have been suggested as an outlet to improve decision making related to cancer self-examinations.[35] Communication researchers have adopted an approach to using crowdsourcing in message selection, which is referred to as a wiki survey.[36] Wiki surveys offer researchers the opportunity to evaluate and generate messages on topics of interest by presenting a pair of messages and asking people to choose which message they believe is a stronger argument (or some other criterion of interest). Participants are allowed to choose "neither," or add their own message/argument. Recent communication science research, for example, requested participants to evaluate and generate arguments related to recreational marijuana legalization.[37] This crowdsourcing approach offers an innovation in measuring perceived argument strength and other perceptions of messages quickly and efficiently, while also offering researchers and practitioners an opportunity to incorporate dynamic, user-generated content during a research study. The combination of computational methods to monitor content and crowdsourcing methods to provide an initial assessment of content offers a novel approach to study the public communication environment about CRC and CRCS, while testing an approach that could be scaled to different users and cancer sites over time.

Crowdsourcing formative evaluation research offers an outlet to identify strong message content, but there is limited evidence on its predictive validity in identifying messages that increase screening and sharing intentions. Extant research supports the use of crowds to assess content quality and generate new content, but there is still a need to establish predictive validity of the approach to determine that crowd selected messages are persuasive.[37] Establishing predictive validity of this approach requires consideration of how selected messages can affect key outcomes (e.g., CRCS intentions) and provide content that can be used for recommended communication strategies (e.g., targeting). Targeted delivery approaches have been successful promoting CRCS behaviors[38] and targeting by race has been effective in promoting cancer screening behaviors.[39] Message targeting by race involves tradeoffs for financially constrained campaigns, however, in that the strategy often requires more resources for message production and placement,[40] and few studies directly compare if race-targeted content outperforms messages found in pre-testing to appeal to a broad cross-section of the population. The most scientifically rigorous way to establish predictive validity of crowdsourced formative evaluation research and test content targeting by racial group preference is to conduct a randomized controlled trial (RCT). Selecting messages from the crowd rankings allows for categorization of high-quality messages both overall and by racial group. This will allow us to design an RCT that provides direct evidence of predictive validity of the crowdsourcing approach for CRCS, and to determine if selecting targeted messages via crowdsourcing improve outcomes for primary (targeted) and secondary audience segments.

Summary of study significance. Disparities in CRC diagnosis and outcomes, as well as suboptimal screening levels, may be due in part to limited knowledge and misinformation. Determining how the public health information environment contributes to reducing information disparities, and in turn screening disparities, offers an important opportunity to address this public health priority. Developing and validating a novel approach to monitoring and evaluating the public information environment using methodological innovations increasingly available to communication scientists. **The proposed project directly responds to the program announcement focus of utilizing and applying new cancer communication surveillance approaches to examine public health communication about CRC prevention and control**. Additionally, the project engages with a traditionally underserved population, Black Americans, who are at elevated risk of CRC.

B. INNOVATION

The present proposal's innovation is developing an overarching framework that functions to monitor and use the online information and message environment to facilitate efficient, timely, evidence-based communication recommendations for cancer control communication efforts. **Having a comprehensive framework to monitor, evaluate, generate, and disseminate accurate information that also demonstrates the ability to motivate action is a necessary next step to strategic cancer communication efforts.** The proposal accomplishes this by using a three-step process that (1) captures and analyzes digital and social media information and misinformation about CRCS, (2) uses a crowdsourcing approach to evaluate and generate information and messages found through monitoring efforts that are most appealing and effective with specific population segments at greater risk for CRC, and (3) tests if the messages identified as most appealing do indeed improve screening and message sharing intentions among target audiences. As such, this project will provide evidence on the efficacy of a conceptual framework to monitor and implement messages from the public information environment to improve cancer communication across the cancer continuum.

Comprehensive monitoring of online information and misinformation about CRCS. This project will offer a comprehensive assessment of public information about CRCS across multiple social network and related platforms (e.g., Twitter, YouTube, WebMD patient portal). As part of the monitoring, we will test and refine computational processes to identify demographic characteristics of messages shared via social media (e.g., age) to offer tools for future researchers to continue to improve public cancer information surveillance.

Testing a new method for evaluating and generating messages about CRCS. Determining what messages and information to disseminate via social media is always a challenge for public health communicators. There have been few methodological innovations to engage in formative research for strategic health communication efforts, particularly methods that do not require intensive, in-person research activities like focus groups and copy testing. Given interest in exploring distance and remote outlets for conducting research in unprecedented pandemic conditions, our test of the wiki survey crowdsourcing approach will offer important evidence to determine the applicability of the method across various cancer communication topics.

Assessing the predictive validity of the novel methodological approach. While computational methods have been used in some capacity in certain health contexts (e.g., tobacco-related messages)[41] where messaging is typically recommending one specific behavior (e.g., quit), but infrequently with topics where recommendations are less straightforward (e.g., multiple options for screening and varied recommendations based on risk and demographic factors).[42] Using the computational methods to feed into crowdsourced message testing has not been tested previously either, which is another part of our novel methodological approach. Finally, our randomized message testing experiment brings the entire approach together by testing the validity of wiki surveys to identify messages that are persuasive among key target audiences.

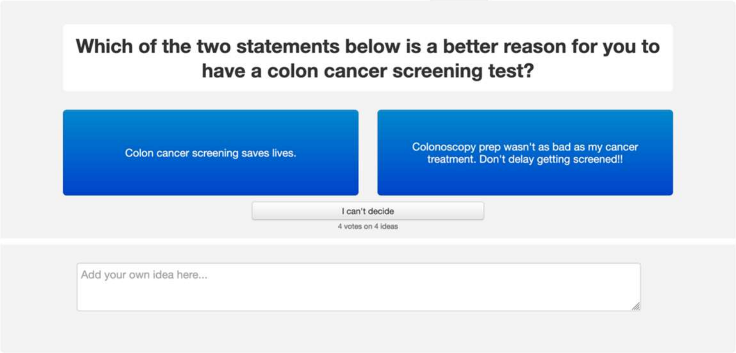
C.1 APPROACH: Theoretical Basis, Design Overview, and Preliminary Studies

Public health communication research and the need for methodological innovation offers a guide to testing our conceptual framework. Communication scientists have focused on integrating innovative methodological approaches as large amounts of public data become more easily accessible and as the ability to connect with audiences of interest has become easier. Our proposal applies approaches advocated by those interested in computational communication science[43] and crowdsourcing for strategic communication improvement[37] to improve cancer communication practice. While past work has implemented computational approaches in monitoring cancer prevention related social media messages,[44-46] prior work compartmentalizes this monitoring process. Often the conclusion of that work is that health communicators will somehow improve their practice and ability to target a future audience of interest because of knowing more about the public information environment. While this certainly may be true and a significant benefit of such approaches, stopping the process there fails to take advantage of the wealth of information collected via these rigorous and innovative computational approaches that allow for more in-depth monitoring of the public information environment than ever before.[47] Indeed, the traditional trajectory of strategic health communication efforts is to begin with formative research, which often includes taking inventory of what competing or contradictory messages exist in the public information environment. This is particularly important for messages about CRCS due to past research discovering that being exposed to two or three messages promoting CRCS can increase participation rates meaningfully.[48] Messages targeted to particular audiences that share motivations and needs related to information are likely to be particularly effective for CRCS.[38] The computational, natural language processing approach to monitoring social media messages is a type of formative research. The next step in strategic health communication efforts is formative evaluation, a process that typically involves focus groups or copy testing approaches.[49] No existing health campaign or strategic health message research has attempted to use a crowdsourcing approach to distribute formative evaluation tasks among a large group of relevant audience members. Unlike focus group approaches that might include the perspectives of 45 to 50 people, comparing 5 to 6 different message possibilities, the crowdsourcing approach to formative evaluation considers hundreds of people's evaluations of dozens of message possibilities. Determining the validity and scalability of these novel methods is essential to innovate formative research and evaluation approaches in the future.

Design overview. *For Study 2*, we will contract a custom, crowdsourced wiki survey using a national sample of adults 45 to 74 years old—including 1000 individuals who self-identify as White or Caucasian and 1000 individuals who self-identify as Black or African American—to choose preferred messages curated from the social media monitoring occurring during the first year of Study 1. Data collection will occur over two and a half months, with 100 people from each targeted group participating every week. This approach allows us to integrate messages generated by participants, as well as new messages discovered during the continuing monitoring of social media messages. We will include 40 to 60 messages, to be displayed randomly in pairs, for the first week of data collection (see Figure 1). The original message set will be supplemented with crowd-generated messages on a weekly basis. Based on past wiki survey research,[37] we expect participants to generate approximately 800 message suggestions of which approximately 5% (n = 40) will be novel (i.e., not duplicates) to the message set. We expect each participant will respond to at least 15 randomized pairs of messages, totaling at least 30,000 message choices crowdsourced in the study.

C.2 APPROACH: Planning and Preparation, IRB

We will develop study protocols that protect human subjects in accordance with a single-site IRB (at Iowa State University), in collaboration with IRBs at collaborating institutions, as required by federal regulations and university operating policies. Research related to Aim 1 does not require IRB approval because it does not involve human participants. Studies for all three aims will be registered with OSF.io, the registration website of The Open Science Framework, and we will also register the RCT (Aim 3) on clinicaltrials.gov. The PI will work with the survey company (AmeriSpeak/NORC) to program and implement the studies to be carried out for Aims/Studies 2 and 3 to ensure that they protect the health, safety and rights of human subjects.



Which of the two statements below is a better reason for you to have a colon cancer screening test?

Colon cancer screening saves lives.

Colonoscopy prep wasn't as bad as my cancer treatment. Don't delay getting screened!!

Figure 1. Sample Choice Screen from Wiki Survey

C.3 APPROACH: Aim 2, Crowdsourcing Message Evaluation and Generation Using Wiki Surveys

The purpose of Aim 2 is to offer a crowdsourced alternative to traditional formative evaluation research that requires considerable economic and temporal resources, as well as face-to-face contact, to conduct. Wiki surveys, if demonstrating validity in identifying effective messages, also serve to promote rapid deployment of messages and information to counter widespread misinformation or contradictory public information about CRCS.

Wiki Surveys. Compared to traditional formative evaluation research options, wiki surveys allow us to collect as much data as each participant is willing to provide (i.e., participants can choose to complete as many comparisons as they like). Wiki surveys also afford us the opportunity to integrate participants' new ideas into the survey that may not have been captured via social media monitoring or that newly emerge over time. Wiki surveys, while not used frequently in communication research, have been deployed successfully since 2010. An online resource (https://allourideas.org) offers researchers an adaptable, open source platform to implement on online platforms. Another example of the wiki survey application include using the approach to obtain residents' suggestions for a citywide sustainability plan.[36]

A wiki survey asks participants to choose their preferred message from a pair of randomly selected messages (e.g., between message A and message B, randomly selected from a seeded pool of messages). In addition to choosing between messages, participants can also contribute new messages, which are subsequently presented to future participants. Using this approach, data collected from multiple pairwise comparisons from a large number of participants can be analyzed to determine the relative rankings of each message across the entire message set. For the current study, we will present participants with message choices and ask which of the messages offers a better reason to adhere to CRCS recommendations.

Message Selection. The grant team will seed the initial list of choices with at least 40 to 60 messages selected from Study 1. Messages will be selected from the library collected during Study 1 from social media platforms and popular health websites. All messages presented to participants will be reviewed by the medical consultant on the grant (Dr. Rich Hoffman) to ensure participants are not rating messages that include any misleading or incomplete information. Messages will be selected by the grant team based on their review of the library of message and suggestions from the medical consultant who has research and practice experience with cancer screening and health disparities. Once the messages are selected, we will work with our contracted survey provider—AmeriSpeak/NORC—to input the messages into the customized wiki survey tool.

Participants. AmeriSpeak/NORC will provide a sample that combines members of their panel and a third-party non-probability panel for a portion of the sample of Black Americans. This is necessary given the goal of having a large sample of a traditional under researched (in communication science) and underserved population (Black Americans between the ages of 45 and 74). For Study 2, the total recruited sample (N = 2,000) will be evenly split between White American adults aged 45 to 74 (n = 1,000) and Black American adults aged 45 to 74 (n = 1,000). The reason for sampling participants from age 45 is that many screening recommendation options for higher risk populations—including Black Americans and individuals with other comorbidities—begin at age 45. *Individuals who participate in Study 2 will not be eligible for Study 3.* We estimate Study 2 will take participants approximately 15 to 20 minutes to complete.

Procedure and Message Integration. Once participants complete informed consent procedures, administered electronically by the survey contractor, the survey will begin. We will first present demographics questions followed by the wiki survey task, embedded within the larger survey platform. We will provide participants with instructions about how to complete the wiki survey component, as well as basic information about what the research study references when it mentions colon cancer screening. Based on procedures and our agreement with the contractor, participants will be told they can respond to as many message pairs that they like. The contractor estimates that participants will likely complete 20 to 25 choice pairs based on typical user engagement. After the first week of data collection, the PI (King) and one co-I (Niederdeppe) will oversee graduate students who will sift through crowd-generated messages to remove messages that duplicate information already in the message set, as well as messages that might be offensive or unrelated to the study. We will integrate valid, novel messages generated via crowdsourcing into the wiki survey on a weekly basis. The wiki survey will be programmed to prioritize presentation of the newly-added messages to even out how many times messages are evaluated—though presented messages will continue to be randomly presented in pairs to participants. This will occur every week for 10 weeks until data collection is complete for Study 2. With each pair of messages displayed, participants will be prompted with the following question: “Which of the two statements below is a better reason for you to have a colon cancer screening test?”

Measured Variables. The survey contractor will monitor and ensure data quality for participants within the AmeriSpeak/NORC panel and from the third-party provider. We will collect demographic information on participants including age, sex/gender identity, educational obtainment, ethnicity, income, employment status, housing type, access to health insurance, and CRCS status. Outside of demographic variables, the key outcomes for Study 2 will be the choices from the presented message pairs, as well as crowd-generated messages. We will use this information to rank the quality of messages but also provide information on how many messages researchers might expect to be generated by the crowd using this methodological approach, including considering how sex (as a biological variable) affects rankings.

C.4 APPROACH: Specific Research Questions and Hypotheses

Study/Aim 2 – Wiki Survey

Wiki surveys offer a method for using the perceptions and perspectives of large groups of targeted audiences in evaluating and generating messages about a topic of interest. Still, less is known about how many unique messages researchers and practitioners are likely to generate using this approach. Related, there is scant evidence regarding the quality of messages generated by this approach to soliciting message ideas. Based on these unknowns about the utility of a crowdsourced approach to message generation via wiki surveys, we propose the following two research questions.

RQ: *How many unique messages about CRCS are generated by wiki surveys in the context of CRCS?*

C.6 APPROACH: Data Analysis Plan

Analyses for Study/Aim 2. The wiki survey approach of Study 2 requires analysis and aggregate ranking of people’s message selections from message choice pairs. To analyze these data, we will fit a Bradley-Terry model. Engaging this approach allows us to generate a relative ranking of statements. More specifically, Bradley-Terry models use a generalized linear modeling approach to provide a log odds estimate regarding if one message will outperform another in a paired comparison with a one statement set as a reference item. Past work using wiki surveys has used the median item as the reference category,[37] which is the approach we will use for analyzing data from Study 2. The coefficients produced by the procedure can be used to rank messages where better performing messages have a higher value than lower performing messages. We will work with the statistical expert on the project to ensure the Bradley-Terry models fit for the Study 2 data, including fitting separate models to consider individual differences[62] for factors such as education and access to insurance, and to account for non-independence of observations that arise from the fact that some respondents will choose to rate more argument pairs than other respondents.

Power analysis. Study/Aim 2 will fit a series of Bradley-Terry models to the choice data provided by the wiki survey and this analytical approach produces ranking that can be produced with varied sample sizes. Given the potential to test up to 100 messages by adding crowd-generated messages, the study design will display each message at least 300 times and all possible choice combinations (n = 9,900 assuming 100 message options) will be evaluated at least once, which is recommended in paired comparison data.[64]