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Toward a Better Understanding of Social Network Site Engagement in Influencing Health Behaviors: An Examination of the Relationship Between Message Framing, Endorsement Cues, and User Engagement

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Toward a Better Understanding of Social Network Site Engagement in Influencing Health Behaviors: An Examination of the Relationship Between Message Framing, Endorsement Cues, and User Engagement

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by

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Abstract

The use of social network sites (SNS) to deliver health interventions has been on the rise in recent years due to their popularity among the general population and functionalities that facilitate interactions with the content, or with other users of SNS. Despite that, scholars have noted challenges, including low engagement, associated with SNS-delivered interventions. This dissertation's overall purpose is 1) to document the current state of measuring engagement within SNS-delivered health interventions, and 2) to empirically examine the interplay between message framing, social endorsement and engagement in a randomized experiment using Instagram.

Results from the scoping review showed that a majority of studies continue to use micro-level engagement indicators to define engagement with a given intervention, and few studies examined engagement as a potential effect modifier of intervention effect, making it difficult to ascertain the type of engagement that matters the most in driving behavioral change. Results from our experimental study (n=528) that utilized Instagram to deliver a human papillomavirus (HPV) vaccine promotion information showed that micro-level engagement did not mediate the relationship between framed messages and vaccination intention; instead, the study suggests that the effect of the communication intervention was partially mediated through positive emotion evoked as a result of reading the intervention material. Additionally, the study suggests that heuristic cues displayed on SNS, such as number of likes, could confer social endorsement effect, such that individuals will be more likely to "like" and "share" the post when they see many people have also liked the post. However, no differences were observed in terms of credibility perception between participants who were exposed to a post with high number of likes vs low numbers of likes in the current study context.

This dissertation's findings contribute to gaps in our understanding of engagement in the context of SNS-delivered interventions. Future works that incorporate multiple dimensions of engagement or utilize multiple methods will further our understanding of engagement and improve ways in which we can best utilize SNS for health intervention purposes.

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Chapter 1:

Introduction

Digital health interventions, or the use of discrete functionality of digital technology to achieve health objectives (World Health Organization, 2019), have become increasingly common with the burgeoning technology advances. Digital health can take many forms, such as automatic text-message programs, mobile applications, telemedicine, sensor technology/ wearable device, social network sites, artificial intelligence (AI)-enabled health solutions and many others. The use of digital technologies could improve access to health information and facilitate personalized or tailored contents for individuals. For practitioners, using digital technologies could potentially reduce cost and improve the delivery of intervention contents. Of particular interest in this dissertation are the applications of social network sites (SNS) for health intervention.

The reach of SNS makes it a promising digital health interventions vehicle. About 72% of the US population used at least one SNS in 2021, with young adults (ages 18-29) reporting the most use (84%) (Auxier & Anderson, 2021). As more Americans have adopted SNS, more behavioral researchers and practitioners have turned to SNS to intervene upon health behaviors (Pagoto et al., 2016). SNS can rapidly reach a broad audience with health information, facilitate discussion around health information, and combat health misinformation. With the increasing number of young adults searching for health information online (Pew Research Center, 2015), it is imperative that health communication researchers understand not only the consequences of engaging with health information on SNS, but also the different factors that may influence engagement with health content in the context of SNS.

A wide range of social-media-based interventions have been documented to-date. First, SNS may be used by organizations or practitioners to offer a variety of resources including health information to specific population, and directing target audiences to additional resources. Furthermore, SNS may be used to support two-way interactions between online community members and or between community members and health professionals, promoting exchange of information, increasing social support and or influence other interpersonal behavioral change pathways. It is also notable that SNS may also provide opportunities to reach hard-to-reach populations and provide an advocacy platform for social mobilization and other health issues.

Although SNS health behavior interventions are still in their infancy, an early meta-analysis (Laranjo et al., 2015) showed a slight net positive effect of SNS interventions on behavioral change. However, heterogeneity exists in participant attrition, and low engagement was reported; a systematic review showed that most social-media-based behavioral studies achieve a 5-15% program fidelity (Maher et al., 2014). If a digital intervention fails to engage participants, it is sensible that it will fail to change participant attitudes, behavioral intention, and ultimately, behavior adoption. Given this, researchers have called for more studies on the science of engagement (Pagoto & Waring, 2016) to better guide the development of interventions to facilitate attention to and digestion of health information in the digital space.

Researchers have proposed the following multidimensional definition for engagement for digital health interventions: "*Engagement with digital health behavior interventions is (1) the extent (e.g., amount, frequency, duration, depth) of usage and (2) a subjective experience characterized by attention, interest and affect.*" (Perski et al., 2017) This has renewed and generated broad interest in better defining and measuring engagement with digital health interventions. For example, Short et al. (2018) provided an overview of different qualitative and

quantitative methods to assess these various cognitive, affective, and behavioral aspects of engagement in digital health interventions. Despite this, little has changed in the context of social-media-based interventions. In a recent systematic review published in 2021 focused on SNS intervention engagement among sexual and gender minorities (Escobar-Viera et al., 2021), it was found that the extent of usage (i.e., the amount, frequency…etc.) continued to be emphasized in measurement and reporting, underscoring the importance of further evaluation in this area.

To address these critical research gaps in health communication and behavioral science, this dissertation further examines the role of engagement, specifically in the context of social-media-based interventions, through three interlinked studies.

The first study is a systematic scoping review of current literature to understand how engagement is measured in current health behavior studies using commercial SNS as the intervention delivery vehicle. Despite the increasing popularity of using SNS for health interventions, there is a dearth of studies that have attempted to look at how engagement is measured and in facilitating behavioral change (Escobar-Viera et al., 2021). In addition, with the ever-evolving features on those platforms, it is vital to stay updated on how current research measures engagement so gaps and future directions can be identified. The goal of the systematic scoping review will be to understand *1) the volume and variety of platforms and features researchers are using on SNS-delivered interventions, 2) different ways in which engagement is measured, and 3) gaps and limitations for measuring engagement for social-media-based interventions.*

In line with the engagement definition proposed by Perski et al. (Perski et al., 2017), the second study examines the role of message framing in generating macro (i.e., cognitive and

affective processing) and micro (i.e., behaviors on the platform) engagement and subsequently vaccination intention with communication messages on SNS, using human papillomavirus (HPV) vaccine promotion and Instagram as the case study. The HPV vaccine is recommended in the US for everyone through age 26, if not adequately vaccinated when younger (Centers for Disease Control and Prevention, 2022). However, among young adults ages 18-26 who did not receive HPV vaccination, only around 40% initiated their first dose of HPV vaccine and 21% complete the recommended doses, suggesting a low vaccination uptake rate in this population (Boersma & Black, 2020). Recent study by Koskan et al. (2021) suggest that college students, a population that significantly overlaps with the age group 18-26, prefers to consume HPV information in the form of education videos and infographics on platforms such as YouTube and Instagram. The study will generate additional evidence on engagement as potential mediation pathways of the message effects on SNS. Specifically, the second study aims to answer *is the relationship between message framing and HPV vaccination intention for mediated by message engagement on Instagram*?

The final study looks at the moderating role of social endorsement in generating different kinds of engagement with HPV vaccine promotional content. Unlike traditional communication channels (e.g., posters, radios, TVs), SNS provide additional endorsement heuristic cues (e.g., number of likes, upvotes, shares, comments…etc.) about the content due to its interactive nature. In turn, these social endorsement cues have been found to influence information processing. Sometimes called the "bandwagon effect," these cues can lead individuals to agree and trust the information more when the information has been endorsed by many others (Lin et al., 2016; Sundar et al., 2009). However, despite these findings, little is known about the interplay between messaging framing and social endorsement on different kinds of engagement with a health

promotion post on SNS. As such, the third study aims to answer *whether the presence of social endorsement influence cognitive, affective, and behavioral engagement with HPV vaccination promotion messages on Instagram.*

As the SNS landscape continues to evolve, it remains critical that health communication practitioners and researchers stay updated on current practices of how to best engage the target audience and to further expand the evidence base of using these platforms for behavioral health intervention. Accomplishing these studies will allow researchers and practitioners to gain a better understanding of SNS engagement in the context of behavioral health studies, to elicit essential insights into the mediating roles of engagement when promoting health information on SNS, and to explore context, such as social endorsement cues, in which engagement will most likely encourage persuasion of health messages.

Chapter 2:

Literature Review and Theories

Human Papillomavirus (HPV)

The Human Papillomavirus (HPV) is the most prevalent sexually transmitted infection in the US. HPV can be transmitted through any intimate skin-to-skin contact between sexual partners, including vaginal–penile sex, vaginal–oral sex, penile-anal sex, penile–oral sex, and the use of sex toys or other objects. The infection can pass easily between sexual partners, with estimates for the probability of infection with the virus exceeding 80% for women and 90% for males across their lifetime (Chesson et al., 2014).

Although HPV is prevalent, not all HPV viruses are cancer-causing. There are about 14 high-risk HPV strains currently identified, including HPV 16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, 59, 66, and 68 (*HPV and Cancer - NCI*, n.d.). Among those, HPV16 and HPV18 have been found to cause the majority (~70%) of HPV-related cancers in the US (Viens et al., 2016). Persistent infections with the high-risk HPV viruses can cause cancers where HPV infects the cells, such as the anus, cervix, oropharynx (i.e., back of the throat), penis, vagina, and vulva (*HPV and Cancer - NCI*, n.d.). Although cervical cancer has traditionally been the focus of HPV prevention effort because HPV causes virtually all cervical cancer cases, high-risk HPV strains are actually responsible for the majority of anal (90%), vaginal (75%), oropharyngeal (70%), vulvar (70%), and penile (~60%) cancers as well (*HPV and Cancer - NCI*, n.d.).

HPV infections can cause a significant economic burden to society. For example, it is estimated that the diagnosis and treatment of HPV-related cervical abnormalities and genital warts cost approximately $2.9 billion yearly for both females and males (Chesson et al., 2014). In another study looking at noncervical cancers, the economic burden of four types of HPV

(including 6, 11, 16, and 18) alone is approximately $418 million (Hu & Goldie, 2008),

underscoring the importance of focusing on HPV prevention.

Human Papillomavirus Vaccines

The HPV vaccine has been available in the U.S. since 2006 to prevent the cancer-causing

strains of HPV. The three versions of the vaccine are Cervarix, Gardasil, and Gardasil-9, where

Gardasil-9 has been the only HPV vaccine distributed in the US since late 2016 (Centers for

Disease Control and Prevention, 2021a). Gardasil-9 can prevent HPV strains that cause up to

90% of genital warts (Zhai & Tumban, 2016). The detailed vaccination schedule for the HPV

vaccine can be found on the Centers for Disease Control and Prevention (CDC) website (Centers

for Disease Control and Prevention, 2021b). The U.S. Food and Drug Administration (FDA)

approves the HPV vaccine for males and females 9 through 45 years of age; however, CDC's

Advisory Committee on Immunization Practices (ACIP) only recommends routine HPV

vaccination for everyone until age 26. For adults ages 27 through 45 years, healthcare providers

can consider discussing HPV vaccination with people who are most likely to benefit through

shared clinical decision-making discussions. The vaccine is administered in two doses, 6-12

months apart, to individuals between 9 to 14 years old. For individuals aged 15-45 or considered

immunocompromised, three doses of the vaccine are administered. The second dose is given 1-2

months after the first dose. The third dose is given 6 months after the first dose.

As of July 2020, only five jurisdictions (District of Columbia, Puerto Rico, Rhode Island,

Virginia, and Hawaii) require children to be vaccinated for school attendance (National

Conference of State Legislatures, 2020). Therefore, the choice to vaccinate or not to vaccinate

against HPV is usually decided by parents with children within the recommended age range for

the vaccine. The CDC recommends administering the HPV vaccine to children before they

become sexually active (*HPV Vaccine Schedule and Dosing | CDC*, n.d.). By vaccinating at an early age, the chance of becoming infected with high-risk HPV decreases substantially. In a landmark study (Lei et al., 2020) of over 1.6 million women, the HPV vaccine's efficacy was particularly pronounced among girls vaccinated before age 17, where the study found a nearly 90% reduction in cervical cancer incidence during the 11-year study period compared with the incidence in females who had not been vaccinated. If an individual was not vaccinated as a child, the individual could be administered the catch-up dose. HPV catch-up doses are currently recommended between the ages of 18-26. Given that only 58.6% of US adolescents from 13-17 are up to date in 2020 (Pingali et al., 2021) and that as age increases, the likelihood of individuals receiving the HPV vaccine decreases (Fontenot et al., 2014), it is important to target young adults for the catch-up vaccination, as it represents a period where they first can independently make medical decisions. In a recent brief based on the Health Information National Trends Survey (HINTS), only 64% of US adults had ever heard of HPV, and only 60% had ever heard of the HPV vaccine in 2020 (National Cancer Institute, 2022), further suggesting a significant deficiency in awareness and knowledge in this population and the need to tailor intervention for this population.

The CDC has published several reports regarding the safety of HPV vaccination over the years. According to the reports, the HPV vaccine is a well-tolerated and safe vaccination (CDC, 2021). A study by Gee and colleagues (Gee et al., 2011) was conducted from 2006 to 2009 in which 600,558 doses of the HPV vaccine were administered. Of those individuals who were administered the vaccine, 105 participants reported adverse reactions such as Guillain-Barre syndrome, appendicitis, or stroke within forty-two days after receiving the HPV vaccine. According to this study, less than 0.02% of those who received the vaccination experienced

serious adverse symptoms after receiving the vaccine. The CDC also reported that no deaths had been linked to the HPV vaccine. Based on these reports and the anticipated benefits of the vaccination, a strong case for vaccinating all children and young adults can be made.

HPV Vaccine Uptakes Among Young Adults

HPV vaccination uptake decreases significantly among young adults ages 18-26 compared to adolescents who received them prior to turning 18. According to results from the National Health Interview Survey (NHIS) in 2018, 39.9% of US adults ages 18-26 initiated the first dose of the HPV vaccine, and 21.5% received the recommended doses (Boersma & Black, 2020), suggesting a significant deficit in vaccination uptakes. Several factors were found to correlate with lower HPV vaccination uptakes in this age group, including if they were men, had a high school diploma or less (compared with college graduates), and were born outside the United States (Adjei Boakye et al., 2018).

Since this age group significantly overlaps with the college population, several studies have also explored factors that may influence HPV vaccination uptake among college students. Studies have suggested that many college students lack awareness of HPV vaccine (Kellogg et al., 2019; National Cancer Institute, 2022). Additionally, Thompson et al.(2016) found that younger college students were more likely to receive the HPV vaccines compared to older college students. For college males specifically, Tatar et al. (2017) found that HPV knowledge, talking to a healthcare provider, and social norms correlate with higher vaccination rate while being in an exclusive sexual relationship is associated with lower vaccination rate. These results suggest that college-age population may be an important group to target for catch-up HPV vaccination, and particular subgroups, such as older college students, may benefit from targeted intervention.

Social Network Sites (SNS)

Social network sites, or social media is an ever-evolving term that is complex to define. Earlier scholars have defined online SNS as a "group of Internet-based applications that build on the ideological and technological foundations of Web 2.0, and that allow the creation and exchange of user-generated content" (Kaplan & Haenlein, 2010). Unlike Web 1.0, where websites are static and website owners have full control of the contents, Web 2.0 was highlighted for its dynamic interface that allowed active participation and interaction from users and had distinguishing features such as: 1) facilitation of sociality among users, 2) ability to post contents of different forms (e.g., photo, videos, ratings), and 3) cross-platform communications that enhance ease of use (Cormode & Krishnamurthy, 2008).

Social network sites, building on these Web 2.0 features, have been described as sites or services that can facilitate the transmission of social interactions, allowing users to connect, collaborate or exchange information (Fuchs, 2014). Attempts to categorize the SNS landscape are difficult as multiple platforms often share the same characteristics, and the creation of new platforms, as well as the ever-evolving features on these platforms, have created challenges for a narrow, focused conceptualization (Obar & Wildman, 2015). For example, Facebook and Twitter have attempted to become a platform for multiple types of communication and information activities, including those related to interpersonal communication, group discussions, and the consumption of mass media content (Y.-C. Kim et al., 2019). Some scholars have also provided the following categorizations, including social networking sites (e.g., Facebook, LinkedIn), blogs (e.g., Twitter), content communities (e.g., YouTube, Instagram), and short message services (e.g., WhatsApp) (Korda & Itani, 2013). However, regardless of its current conceptualization and categorization, the idea central to the definition of SNS is in its interactivity and sociality, which

emphasizes engagement, communities, connection, and collaboration (Fuchs, 2014).As such, SNS is broadly defined as any platforms that allow users to create personal profiles, post content, and establish new or maintain existing relationships for the current dissertation.

Social Network Site Use in Young Adults

SNS has steadily become more popular in the US in the past decade, from 53% of US adults reporting using at least one SNS site in 2012, to 72% in 2021 (Auxier & Anderson, 2021). While the overall prevalence of SNS use has increased across generations, it continues to be most prevalent among younger adults. Based on Pew Research Center, 84% of young adults ages 18-29 indicated they ever use any SNS sites, and of those, 95% use YouTube, 71% use Instagram, 70% use Facebook, 65% use Snapchat, 48% use TikTok, and 42% use Twitter (Auxier & Anderson, 2021). Not only are young adults more likely to ever use those platforms, but they are also utilizing these platforms at a higher frequency. For instance, 71% of Snapchat and 73% of Instagram users ages 18 to 29 reported using these platforms daily (Auxier & Anderson, 2021).

There are different reasons why young adults may engage with SNS, from being an entertainment source (e.g., unwinding), information sharing (e.g., expressing opinion), information seeking (e.g., future events), social connection (e.g., everyone else is using it), professional advancement (e.g., network), and passing the time (Papacharissi & Mendelson, 2011). These different motivations to use SNS also have implications for the type of features they may engage with. Indeed, SNS provides a variety of opportunities for user engagement, such as sharing different types of user-generated content (e.g., photo sharing, status updates, location sharing), to interacting with other users (e.g., commenting, liking, and sharing on posts, direct messaging) to forming online communities (e.g., Facebook Groups, Twitter

Communities). A study (Smock et al., 2011) has found that college students with motivation for social interaction will be more likely to comment, post statuses, as well as engage in private messaging with others on Facebook, suggesting that SNS use is not uniform across individuals and formative research about the audience SNS use motivations may be important for effective use.

SNS Use for Health Intervention

SNS is increasingly a popular vehicle of choice for intervention delivery due to its high usage across generations. Early studies that make use of SNS for behavioral health interventions have found mixed results. In two meta-analyses of social-media-based health behavior interventions (Laranjo et al., 2015; Maher et al., 2014), the authors found that social-media-based interventions had an overall small net positive effect on health behaviors. Interventions utilizing SNS may take on different forms due to the plethora of features available on those platforms. First, SNS may be used by organizations or practitioners to offer a variety of resources including health information to specific population, and directing target audiences to additional resources. For example, a content analysis showed that organizations such as Susan G. Komen capitalize on Breast cancer Awareness Month and utilizes Twitter to share breast cancer related contents that targets different Health Belief Model's constructs (Diddi & Lundy, 2017). Additionally, SNS may be used to support two-way interactions between community members and or between community members and health professionals. For example, Facebook groups have been tested as a mean to increase social support to among smokers to help with smoking cessation (S. J. Kim et al., 2017). In some cases, researchers further gamified the intervention to promote engagement in the online communities. Mendoza and colleagues's Facebook intervention (Mendoza et al., 2017) motivate participants by sharing achievement in physical activities goals and setting group

challenges. In many cases, the use of SNS is incorporated as part of a multi-component intervention and complemented by other components, such as a website, a text-message program, or multiple SNS platforms. For example, Pechmann et al. (Pechmann et al., 2017) tested an intervention where automated daily tweets were used to encourage discussion about quitting smoking on Twitter in addition to an automatic feedback text message program as well as usual care such as nicotine patches. As SNS platforms continue to evolve with new features to match with user preferences,

SNS Intervention for HPV Vaccination

A limited, but growing body of literature using SNS to promote HPV vaccination uptakes has emerged in recent years. Chodick et al. (Chodick et al., 2021) , in a randomized trial on Facebook, found that HPV vaccine Facebook campaign may have differential effects based on the population characteristics. They found that the campaign increased adolescent vaccination uptakes by 6% among low-median SES parents but reduced the uptakes by 10% for low SES parents, suggesting audience segmentation may be important to understand salient beliefs among subgroups that should be tailored in an intervention.

In another study by Sundstrom et al. (Sundstrom et al., 2021), the team implemented a 10-week SNS campaign on Twitter and Facebook during summer to match with the back-to-school schedules and found that they were able to generate over 370,000 impressions and over 2,700 engagement (e.g., likes, comments…etc). They further found, through qualitative content analysis, that misinformation related to HPV vaccine are often countered by peers on the campaign posts, suggesting that creating opportunities for target audience to engage with HPV

vaccination on SNS may be a viable way to correct some misinformation related to the HPV vaccines.

Furthermore, Brandt et al. (Brandt et al., 2020) tested an intervention using private Facebook groups and emails with a small college population and found the program to be highly engaging, with 97% of participants liking or commenting at least once and that intervention group significantly improved HPV knowledge compared to the control, suggesting the promise of SNS to target college students for catch-up HPV vaccination uptakes.

Most recently, Leader et al. (Leader et al., 2022) tested narrative-based SNS posts on Instagram with a group of young women ages 18-26 and found that higher video engagement was associated with stronger behavioral intention to talk to a physician, family/friends, and to vaccinate, further providing evidence that engaging information on SNS can lead to positive health outcomes. Overall, these early results points to the promise of engaging individuals on SNS as a complementary tool to further encourage HPV vaccination uptakes.

Engagement with Digital Health Interventions

Although early meta analysis (Laranjo et al., 2015; Maher et al., 2014) showed a net positive effect for social-media-based interventions for behavioral change, several shortcomings, including program engagement, were noted for consideration. For example, it was reported that even among people who do seek out digital health tools, many would only use them for only a few days or weeks at most, suggesting a lack of long-term engagement (Eysenbach, 2005). Maher et al. (Maher et al., 2014) also pointed out that the majority of SNS-based interventions may reach only 5-15% of program fidelity, suggesting overall poor engagement with interventions. Most recently, in Napolitano and colleagues' (Napolitano et al., 2021a) Facebook weight-loss intervention for college students, it was found that although there was no overall

effect of the treatment group over time on weight loss, participants who were highly engaged (defined as completed 66% of program activities) lost more weight compared to the control group, providing further evidence for the importance of engagement in influencing the efficacy of a given SNS intervention.

For HPV intervention specifically, Asare et al. (2021) systematically examined SNS and mobile-driven interventions for HPV vaccination using the Reach, Effectiveness, Adoption, Implementation, and Maintenance (RE-AIM) framework. It was found that although the majority of the studies reported internal validity measures, external validity measures, including adoption (40.3%), implementation (45.6%), and maintenance (26.5%), were not consistently reported by articles, suggesting that there are limited data that can help translate efficacious interventions into real-world implementation, and specific studies related to design and implementation of interventions on SNS should be emphasized.

Of particular interest to researchers is how engagement is being conceptualized and measured on SNS, as it can be defined very differently from intervention to intervention depending on the platforms used. To that end, Perski et al. (2017) have proposed the following integrated definition based on their review of 117 articles related to engagement with digital behavior change interventions (DBCIs): "*Engagement with DBCIs is (1) **the extent** (e.g., amount, frequency, duration, depth) of usage and (2) a **subjective experience** characterized by attention, interest and affect*". This multidimensional construct speaks to not only the micro behaviors (number of likes, comments, shares…etc.) that one may perform on a given platform, but it also speaks to the macro level factors such as cognition and affect that have been shown to influence behavioral attitudes and intentions. The current dissertation will be guided by this definition of engagement.

Health Message Framing

Developing persuasive messages is one key strategy utilized by health communication practitioners to motivate individuals and communities to adopt healthy behaviors. However, communicating behavioral change is often complex and requires careful planning. Healthy People 2030 (Healthy People 2030, n.d.) has identified improving health communication as a key goal for the decade to make health information more easily understandable and actionable.

There are multiple ways to design a health message to increase the persuasiveness of an individual to adopt or modify health behaviors. A message could emphasize the outcomes that an individual will either obtain or avoid as a consequence of performing a particular behavior or lack thereof. The way in which a health message is framed has been documented to contribute to the persuasiveness of the message across multiple health topics (e.g., physicial activities, smoking, oral health…etc), and this simple manipulation of framing has been shown to lead to persistent behavioral change (Gallagher & Updegraff, 2012). As such, health communication practitioners' choice of framing in relation to the consequences of performing a particular behavior has implications for its persuasiveness.

Much of the current health message framing research is based on Rothman and Salovey's application (Rothman & Salovey, 1997) of the Prospect Theory (Tversky & Kahneman, 1981) to health communication. According to Prospect Theory, individuals are more risk-seeking when they are faced with a decision under the conditions of risk (i.e., loss) and are more risk-averse when they are confronted with a decision under the conditions of little risk (i.e., gains). Rothman and Salovey proposed that the extent of the risks (e.g., safe or risky) associated with a health behavior should determine which form of framing would most likely motivate behavior change. In health communication, this idea of risk has been typically operationalized as the extent to

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which an individual runs the risk of finding out about an illness. For instance, with behaviors, such as cancer screening or HIV testing, that are viewed as a high-risk behavior where individuals may discover health issues, people would be more likely to choose to engage with the risks when consequences are framed as losses. In contrast, for behaviors such as the use of sunscreen and exercising, which they are viewed as low-risk behaviors and have relatively low uncertainty, individuals should be more likely to engage in behavioral change when consequences are framed as gains. Consequently, it has been hypothesized that gain-framed messages should be more effective for preventative behaviors while loss-framed messages should be more effective for detection behaviors in eliciting health behavior change (Rothman & Salovey, 1997). In a meta-analytic review of 94 message-framing studies on health behaviors by Gallagher and Updegraff (Gallagher & Updegraff, 2012), gain-framed messages indeed were found to be more likely than loss-framed messages to encourage prevention behaviors, particularly in skin cancer prevention, smoking cessation, and physical activity. However, loss-framed messages were not found to be more likely than gain-framed messages to encourage detection behaviors, suggesting additional studies need to examine the contexts in which loss-framed messages are most effective.

Framing of Vaccination Messages

Vaccination behavior is of particular interest for message framing studies from a theoretical standpoint. Scholars (Riet et al., 2008) have suggested that the null effect found in message framing may be due to the ease or difficulty of performing a given behavior. That is, behavior being viewed as easy to perform or having a relatively low barrier to perform may be a necessary condition for the observance of message framing effects. In the context of health behavior, it can be understood as when a health behavior is perceived as difficult or complex to

do, no differential persuasiveness may be observed between gain- or loss-frame; however, if a given behavior is perceived as easy to do, framing effects will be observed. In line with such reasoning, vaccination has been proposed as a promising area where such effects can be found because vaccination is not generally considered a complex behavior (e.g., diabetes management) and it typically requires one-time action (or a few follow-ups) from the individual (O'Keefe & Nan, 2012).

The most recent systematic review of message framing in vaccine communication (Penţa & Băban, 2018) pointed out that there are inconclusive findings regarding the potential for message framing alone in influencing the acceptability of vaccines. Four previous studies (Abhyankar et al., 2008; Gerend et al., 2008; Nan, 2012; Van't Riet et al., 2014) have found a main effect for framing on vaccination intention, all of which reported a loss-framed advantage over a gain-framed message, suggesting a departure from Rothman and Salovey's hypothesis that gain-framed messages should be more persuasive for prevention behaviors. Two additional studies (Frew et al., 2014; Lechuga et al., 2011) found no differences between gain- or loss-framing, but both conditions led to a higher vaccination intention compared to a control condition.

Despite inconclusive findings on the main effects, a sizable body of literature found that the relative effectiveness of framing was dependent on characteristics of the message recipient, existing perceived risk, and or other contextual factors (e.g., message design). For example, Yu and Shen (Yu & Shen, 2013) found an interaction between message frames and individualistic versus collectivistic appeals, suggesting that messages focusing on collectivistic losses were effective in promoting the flu vaccine. Understanding conditions and the context in

which elicit a strong framing effect may lead to fruitful results that can help with future audience segmentation efforts.

Methodological Issues with Previous Framing Studies on Vaccination

Although framing has been studied relatively extensively for vaccination communication, key shortcomings have been noted in several methodological areas that this dissertation will aim to avoid.

One weakness in existing literature was the use of a small sample size (O'Keefe & Nan, 2012), which may partially explain the lack of consistent findings in main framing effect in generating vaccination intention. Of the 32 gain- and loss-frame articles for promoting vaccination, O'keefe and Nan (O'Keefe & Nan, 2012) found that the median sample size was only N of 130, where such a sample size would only have a power of 0.21 to detect a small effect size (d = .10) with alpha = .05 based on a two-tailed t-test. It is also possible that significant effects found in small sample studies are outliers, and researchers have called for replication studies with larger samples (O'Keefe & Nan, 2012; Penţa & Băban, 2018).

In addition to sample size, it was noted that very few framing studies include a control arm. Several important questions could be answered by such inclusion. For instance, if gain-frame was found to be more effective than loss-frame for a particular health behavior, it would still be unclear if the implementation of a loss-frame message would be worse than having no framing at all. In another instance, if there is no relative advantage between gain- and loss-frames, the possibility exists that both frames are more effective than a no-frame condition, as found in two previous studies (Frew et al., 2014; Lechuga et al., 2011). As such, it may be increasingly critical for public health scholars to include a control arm when studying message effects in order to detect the unintended effect.

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Lastly, greater attention to stimuli materials was pointed out as a potential problem in experimental studies, especially given the subtlety of framing manipulations (Penţa & Băban, 2018). For instance, in one study (Chien, 2011), the gain-framed intervention included a picture with two physicians (i.e., medical experts), whereas the loss-frame intervention included a picture with a middle-aged man (i.e., a layperson), suggesting that source credibility may be at play here in influencing the persuasiveness of a message.

Chapter 3:

Methodologies

Systematic Scoping Review

Systematic reviews aim to provide a comprehensive, unbiased synthesis of relevant studies in a single document using rigorous and transparent methods (Aromataris & Pearson, 2014). Unlike a typical literature review, a systematic review is noted for its explicit reporting of the methods used in the synthesis. In more recent years, systematic scoping reviews have gained popularity as a tool to determine the scope of a given body of literature. Munn et al. (Munn et al., 2018) provided a summary of goals related to systematic as well as scoping review (Table 3.1) to better differentiate the two review types.

Table 3.1: Goals of Systematic and Scoping Review By Munn et al. (Munn et al., 2018)

Systematic Review	Scoping Review
• To uncover the international evidence • To confirm current practice/ address any variation/ • To identify new practices • To identify and inform areas for future research • To identify and investigate conflicting results • To produce statements to guide decision-making	• To identify the types of available evidence in a given field • To clarify key concepts/ definitions in the literature • To examine how research is conducted on a certain topic or field • To identify key characteristics or factors related to a concept • As a precursor to a systematic review • To identify and analyze knowledge gaps

Based on the goals, the current dissertation will conduct a scoping review because the goal is to identify the variety and volume of evidence available in measuring engagement in the context of a SNS intervention, as well as intervention characteristics or features that may potentially promote engagement.

Path Analysis

Path modeling, originated by Sewall Wright (Wright, 1918, 1921), will be used examine the direct and indirect paths between independent and dependent variables. The path coefficients determine if a given path from one variable to another is statistically significant. In other word, path coefficients test the direction of influence from one variable to another. One common application of path analysis is mediation analysis to test hypotheses about how casually antecedent variables confer their effect on a consequent variable. This dissertation will apply principles of path analysis in Studies 2 and 3 to test a series of causal relationships between variables.

Historically, mediation analysis is typically only conducted after the association between the focal independent variable and focal dependent variable has been established, as proposed by Baron and Kenny (Baron & Kenny, 1986) in its causal step approach. This approach proposes three conditions that must be met in order to support mediation:

1) The independent variable significantly predicts the dependent variable.

2) The independent variable significantly predicts the mediator variable.

3) The mediator variable significantly predicts the dependent variable in the regression where independent and mediator variables are both included.

Complete mediation was said to be present if the independent variable did not significantly predict the dependent variable in the third regression, whereas partial mediation was said to be present if the independent variable significantly predicted the dependent variable.

The simplicity of Baron and Kenny approach makes it a popular approach by researchers; however, in more recent years, methodologists have indicated that a significant total effect of an independent variable on a dependent variable is not a prerequisite for searching for additional

evidence of indirect effects. Studies (Hayes, 2009; Zhao et al., 2010) have shown that it is indeed possible for an independent variable to have an influence on the dependent variable indirectly through a mediator variable even if the researchers cannot establish that there is a total effect different from zero. This could happen in several scenarios. For example, given that total effect is the sum of direct effect and indirect effect in a given model, it is possible that indirect effects and direct effects have similar estimations with opposite values that may lead to the total effect being close to zero. Additionally, Kenny and Judd (2014) found that tests of indirect effects are generally higher in power than tests on total effects given the same sample size, further suggesting that step 1 of the Baron and Kenny method does not need to be met to establish mediation. As such, mediation analysis conducted as part of this dissertation recognize that significant association between an independent variable and dependent variable is unnecessary and emphasizes the estimation of the indirect effects as well as inferential tests of those indirect effects.

The current dissertation will employ a parallel-serial design with three mediators total, with two parallel mediators' antecedent to a third mediator. A generic mediation model for the dissertation can be found in Figure 3.1. The difference between a serial, as opposed to parallel mediation, is the inclusion of the causal path between the mediators. The effect of serial mediation (M1 -> M3 and M2 -> M3) in our generic model will be estimated, while the effect of parallel mediators (M1 and M2) is assumed to be zero (i.e., no arrow between those two mediators). Ordinary least squares (OLS) regression will be utilized to examine whether the demonstrated relationships are mediated by the proposed mechanisms in this dissertation. The direct and indirect effects of the general model can be estimated using the following equations:

$$M1 = i_{M1} + a(IV) + error$$

$$M2 = i_{M2} + e(IV) + \text{error}$$

$$M3 = i_{M3} + c(IV) + g(M1) + h(M2) + \text{error}$$

$$Y = i_{DV} + i(IV) + d(M3) + b(M1) + f(M2) + \text{error}$$

The PROCESS Macro Version 4.1 by Preacher and Hayes (2022) will be used with SAS Version 9.4 (Cary, NC) to estimate path coefficients, standard errors, as well as confidence intervals.

Inference on Indirect Effect of Independent Variable on Dependent Variable through A Mediator

Several statistical approaches have been developed to test for the inference of indirect effect for mediation analysis. One popular option is the use of Sobel's test (Sobel, 1982), or sometimes called the delta method. Because Sobel's test is based on normal theory, typical statistical assumptions about normality must be met. That is, Sobel's test assumes that the sampling distribution of the indirect path is normal; however, empirical studies may not meet such stringent criteria. Several simulation studies (Hayes & Scharkow, 2013) have also found Sobel's test to have one of the lowest statistical powers in detecting indirect effects and may generate unreliable confidence intervals, suggesting the need for inferential tests that do not require normality assumption.

For this dissertation, indirect effect will be estimated using percentile bootstrapping, which does not assume normality. Bootstrapping is a form of resampling method, where original sample size is treated as a representation of the population. Observations (or participants) in this sample are then re-sampled with replacements using the observations in the original sample (i.e., a particular observation may appear multiple times during the resampling), and thus create a bootstrap sample. This process aims to mimic the original sampling process and is repeated a large number of times (e.g., more than 5,000) to create a representation of the sampling

distribution. For mediation analysis, bootstrapping will be used to empirically derive a representation of the sampling distribution of the indirect effect, which will be used to construct the bootstrap confidence interval. If the 95% bootstrap confidence interval does not contain zero, it is said that the indirect effect is significant (p < .05).
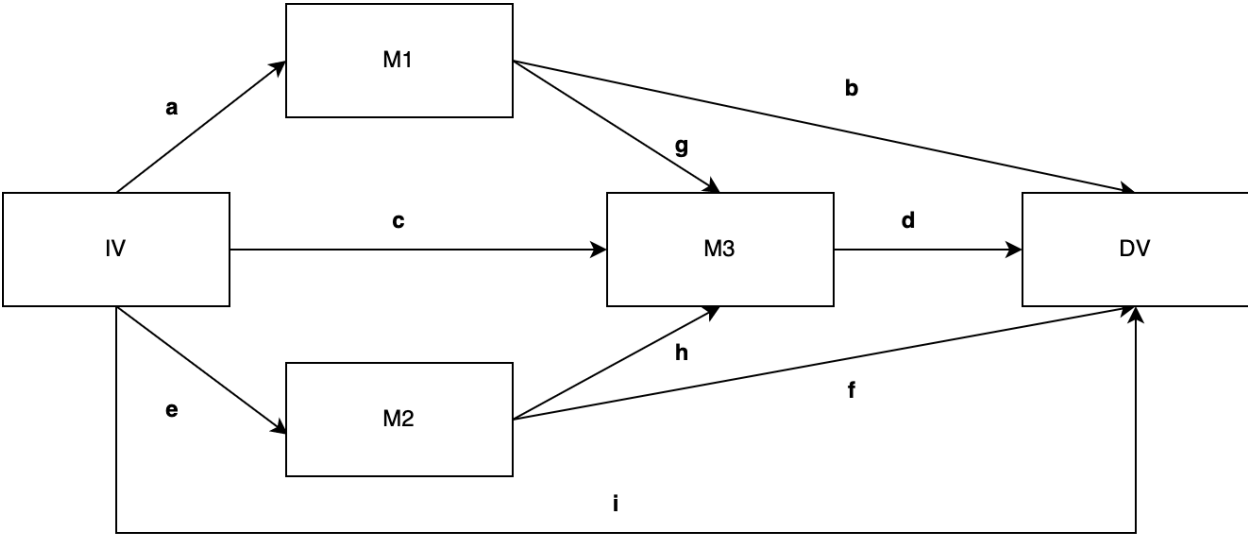
Figure 3.1: Generic parallel-serial mediation model for the current dissertation

Chapter 4:

Study 1 – Engagement Features and Measures in Health Behavior Interventions Utilizing

Social Network Sites: A Scoping Review

Abstract

Background: Despite an increasing interest in using commercial social network sites (SNS) as a health intervention vehicle due to high usage and acceptability, there is a lack of reviews summarizing whether and how scholars are assessing engagement with social network site in the context of health behavior interventions. The purpose of this systematic scoping review was to synthesize the evidence on evaluation of engagement with SNS–delivered health interventions for improving health outcomes.

Methods: We conducted a literature search for studies published between January 2004 and August 2022 using four databases. Articles were included if they were peer-reviewed, in English, used any commercial SNS to deliver intervention, and assessed at least one measure of engagement. A minimum of two authors completed the full text screening.

Results: We included 68 articles in the review; 35 were feasibility studies and 18 were efficacy or effectiveness trials and 15 were real-world programs. The majority of articles focused on physical activity and sexual health. We found heterogeneity in how engagement was defined and assessed, with micro level engagement, such as number of likes, being reported most frequently.

Conclusion: Advancing the science of SNS-delivered interventions will likely require complementary approaches that incorporate both micro and macro level engagement factors and utilize a variety of methodologies.

Introduction

      The rise of social network sites (SNS), or web-based platforms that allow individuals to create their own personal profile and build a network of connections with other users (Boyd & Ellison, 2007), has altered communication significantly and its use has dramatically increased in the last decade. According to the Pew Research Center, over 70% percent of Americans now use SNS to connect with one another, to engage with news content, and to share information, and use of those platforms appears to be increasing across different demographic characteristics such as gender, race, income, community type (Auxier & Anderson, 2021). Further, data suggests that this increase in online activity includes accessing health information (Fox & Duggan, 2013), and that this has resulted in more importance being placed on digital media as an important health information source. Ultimately, this signals an expansion of opportunities health intervention and programming, as more interpersonal interactions take place online in virtual communities and SNS.

      Social network sites could be unique platforms for health intervention due to its different functionalities that provide some degree of interaction and communication among their users. Kiezmann and colleagues (2011) have described the seven building blocks of SNS, some of which including conversation (i.e., the extent to which users communicate with each other), sharing (i.e., the extent to which users exchange, distribute, or receive content), relationship (i.e., the extent to which users relate to each other), reputation (i.e., the extent to which users know the social standing of others and content), and group (i.e., the extent to which users form communities). These building blocks of SNS can provide opportunities for innovative health interventions. For example, the conversation feature allows users to engage in discussions about health topics, share experiences and support each other. The sharing function could enable the

exchange of health-related content, which can educate and inform users. The group functionality could allow users to form online communities centered around specific health conditions or wellness goals, fostering peer support and motivation. Leveraging these unique functionalities, SNS has the potential to serve as effective platforms for health interventions, providing opportunities for information dissemination, social support, and behavior change promotion.

Despite the potential of SNS to deliver digital health interventions where people are, evidence from existing systematic reviews suggest that many SNS-based interventions are closed systems developed by researchers (Welch et al., 2016) and their effect on health behaviors and health outcomes have been mixed, with some finding SNS interventions to have a small overall net benefits on behavioral change while others found no change (Chang et al., 2013; Moorhead et al., 2013; Murray et al., 2004). Additionally, it was found that SNS-based interventions often experience a high level of attritions and less than desired level of engagement (Maher et al., 2014). As such, engagement is proposed as a prerequisite for effectiveness of SNS-based and more broadly, digital health interventions (S. Pagoto & Waring, 2016). That is, if engagement with a given digital intervention is low, it is plausible that the intervention will likely fail to influence behavioral change. However, assessing the engagement with SNS-interventions beyond simply usage had not been emphasized in the research (Welch et al., 2016). The paucity of research around the understanding of engagement within the context of digital health intervention may lead to lack of research questions being asked in this area, and limit our ability to draw general conclusions around its use and influence on health behavior.

Engagement on SNS may be different from other digital technologies. For example, Facebook messages are posted by individuals or organizations, and users can interact with posts by reacting to (e.g., responding with like, sad, angry, laughing, etc.), commenting on, or sharing

them on their profile. At the same time, data suggest that 90% of SNS users are "lurkers," where they silently read and observe contents online, and only 10% of SNS users are active contributors of content that are reacting and commenting (Nielsen, 2006). Both of those usage patterns (i.e., lurkers or contributors) may reflect engagement but may stem from different needs. In the context of digital health interventions, researchers have proposed that engagement have two primary dimensions that get at these usage patterns: (1) "the extent (e.g., amount, frequency, duration, depth) of usage" or micro level engagement and (2) "a subjective experience characterized by attention, interest, and affect" or macro level engagement (Perski et al., 2017). These two dimensions are critical to evaluate in SNS interventions because, while "liking a post" might signal overall usage of the intervention, subjective experiences, such as cognitive or emotional arousal may be a more accurate indicator of engagement within the behavioral change pathway (Yardley et al., 2016). As a result, a wide range of methods, such as qualitative interviews, self-report surveys, ecological momentary assessment, SNS meta data, sensor technology and others, have also been proposed to measure engagement to capture different types of engagement people may have on SNS (Yardley et al., 2016).

Given the increasing interest and number of health interventions delivered through commercial SNS, and continuing conversation around assessment of engagement on SNS and its impact on intervention effectiveness, the current review aims expand on previous research to answer the following questions:

1) What commercial SNS and associated features are researchers using to elicit potential participant engagement?

2) How are engagement operationalized and measured?

3) What engagement-related challenges exist for SNS-based health interventions?

Methods

A scoping review was conducted according to the requirements of the Preferred

Reporting Items for Systematic Reviews and Meta-Analyses Statement (PRISMA) extension for

scoping reviews (PRISMA-ScR) (Tricco et al., 2018). The scoping review protocol was pre-

registered with the Open Science Framework (Protocol #FJZGX).

Inclusion and exclusion criteria

Included articles in the current study must be a 1) health intervention (any activities

undertaken with the objective of improving human health) at least partially delivered through a

commercial SNS, 2) must assess at least one engagement metric, 3) of any study design, 4) in

English, 5) original empirical research study, 6) peer-reviewed, and 7) published between

January, 2004 – August, 2022. Conversely, studies that does not specify any health outcomes and

studies that incorporate SNS solely for the purpose of promoting other treatment components

(e.g., recruiting participants, sign up for SNS, re-routing to a program website) will be excluded.

Additionally, studies that did not utilize any interaction components (Kietzmann et al., 2011) or

two-way communication between participants or participant and the research team were

excluded. For example, an intervention that utilizes one-way message, such as reminder

messages on WhatsApp or Facebook Messenger, would be excluded from the current review.

Health outcomes are not specified for this review since the focus is on how platforms are used to

engage participants and how engagement is measured. Lastly, references from included studies

was also examined to identify potential articles to be added.

Search Strategy

Literature searches using 1) PubMed, 2) APA PsycInfo, 3) EBSCO Academic Complete,

and 4) CINHAL are developed by the lead author and adapted based on previous systematic

reviews that focused on SNS and behavioral health (Chen & Wang, 2021; Escobar-Viera et al., 2021; Laranjo et al., 2015; Perski et al., 2017). An example search strings is included in Appendix A. The searches will be limited to the publication year from January, 2004 (the year Facebook was first launched) to August, 2022. References was uploaded to Covidence, a web-based collaboration software platform that streamlines the production of systematic and other literature reviews (*Covidence Systematic Review Software*, n.d.).

Screening Process

After importing, duplicate references were removed. Screening was conducted in two phases, 1) title/abstract screening, and 2) full-text screening. During the title/abstract screening, the lead author reviewed the manuscript titles and abstracts to generate a set of articles that have some possibility for inclusion. During the full-text screening, two screeners (lead author, and one of trained research assistants) independently assessed the full text of the articles to determine eligibility for inclusion. The three coders achieved substantial interrater reliability, with average weighted Cohen's kappa across coders reaching 0.76 (McHugh, 2012). Consensus meetings between coders were held to reconcile differences.

Data Extraction

Once the screening is complete, the lead author extracted information systematically from each of the included articles. The extraction form allowed for several categories of data, including (1) study logistics (e.g., author, title, year of publication, research design) (2) study participant characteristics (e.g., number of participants, sex, race and ethnicity) (3) intervention characteristics (e.g., SNS platform used, intervention length, theories applied, comparison group) (4) health outcomes and (5) engagement outcomes (e.g., measures used, macro and micro level of engagement).

Results

Study Identification

Figure 1 presents the PRIMSA flowchart for the current scoping review. The search strategies identified 22,302 articles, with 6,850 duplicates and 14,693 records excluded after title and abstract screening. Of 451 articles fully assessed for eligibility, we excluded 6 non-peer-reviewed manuscripts, 245 did not report outcomes of an intervention or program, 95 did not use SNS as part of intervention delivery, 26 didn't use a commercially available SNS, and 17 did not include any engagement metrics. We reviewed the list of references for each included manuscript included in order to identify additional studies, but no new study that met our inclusion criteria were identified. As such, 68 manuscripts were included in the final sample.

Study Characteristics

Of 68 manuscripts included in this review, 35 (51%) reported results of feasibility studies, 18 (26%) reported efficacy or effectiveness trials and 12 (18%) reported evaluation of a real-world program. Characteristics of each study are presented in Table 4.1. Majority of studies (n=46 or 68%) were conducted in the USA, 8 (12%) in Australia, 7 (10%) in China and 7 from other countries (e.g., Thailand, South Korea, West Africa). Social network sites used to deliver the interventions varied across studies, with most popular being Facebook (n=54 or 79%), and Twitter (n=13 or 19%). Almost all studies (n=59 or 87%) reported delivering their interventions incorporating only a single SNS.

Participant demographic characteristics varied greatly across studies. Among studies reported mean age of participants, mean age was approximately 27 years, but studies have used SNS to target anywhere from teens to older adults.

Intervention Characteristics

Characteristics of SNS-delivered interventions evaluated in each included study are summarized in Table 4.2. SNS interventions included in the current review targeted a wide array of health issues, including physical activity/weight loss (n=18), smoking cessation(n=8), sexual health (n=10), and other topics (e.g., indoor tanning, suicide prevention, nutrition/diet).

 Thirty-nine (57%) studies reported using SNS exclusively to deliver the intervention, while 29 (43%) studies use SNS to complement other intervention components, including websites or mobile apps, SMS or test messages, in-person programming (Hughes 2020), or wearable or sensor technology (e.g., Fitbit).

In terms of how SNS is used to potentially generate participate engagement, almost all of the examined interventions reported at least partially exposing participants to some kind of researcher-developed education content through SNS. Notably, 36% of interventions delivered content within a private Facebook group. Studies also reported a variety of ways to help with engagement of participants on SNS, including incorporation of non-intervention content (e.g., pet picture) to increase content variety (Lawton et al., 2022; Meacham et al., 2021; Bonar et al., 2022), study staff posting questions or polls to encourage participation (Mayer et al., 2012; Dulli et al., 2018; Lau et al., 2022; Silfee et al., 2018), and live event hosted on SNS (Curtis et al., 2020; Ramos et al., 2018). One study (Cavallo et al., 2014) also reported providing financial incentive for participants to engage with each other throughout the intervention period.

Engagement Measures

All studies included in the current review used at least one measure of micro level engagement. However, the way engagement is operationalized varied widely across studies. Many studies (81%) used metrics, such as frequency of views, likes, shares or logins, that are

available through SNS. Some studies (Napolitano et al., 2019; Bonar et al., 2022; Looyestyn et al., 2018) assessed total number of intervention activities completed by the user. Randomized trials also included retention or attrition rate as an indicator of intervention engagement. Given the pilot nature of many of these studies, some studies (Sun et al., 2017; Cheng et al., 2020; Mancheno et al., 2021) also included qualitative assessments to learn about usability and user experience with the intervention.

Majority of the studies reported engagement data descriptively; few studies (n=4) further examined engagement as a moderator of intervention effectiveness. In a smoking cessation trial utilizing Twitter, Pechmann (2017) found that participant tweet volume is significantly associated with increased odds of sustained abstinence, with every additional 10 tweets increasing the odds of sustained abstinence by 20% on average. In another study, Napolitano et al. (2019) didn't find overall efficacy of the Facebook + text message program to promote weight loss; however, they found that participants who were more engaged (defined as engaging with at least 66% of intervention content) with the intervention resulted in better physical activity outcome in the short term compared to participants who were not. In a telenovela series delivered over YouTube, Massey et al. (2022) found that different levels of engagement with storyline (e.g., story affected participant emotionally, participant thinking about other things while the program is on) significantly predict participant correctly answer knowledge questions for some storylines.

Discussion

Summary of evidence

In this systematic scoping review, we found a growing number peer-reviewed articles examining SNS-delivered interventions to improve a variety of health issues for different

populations. Importantly, we found an important variation in how studies assessed engagement, with measures focused mostly on micro level engagement. We discuss implications and suggestions below.

A comprehensive set of inclusion criteria for this review was used to capture a broad base of studies that may use SNS to deliver any health interventions. We found that much is still to be learned in tapping into these commercially available SNS for health interventions, with majority of studies reporting feasibility/acceptability (51%). A large majority of these studies was conducted in the last five years. Given the ubiquitous use of SNS in the US, especially teens and young adults (Auxier & Anderson, 2021), and the high acceptability of digital health interventions among this group, SNS holds potential as a delivery modality for behavioral interventions targeting a variety of health issues.

In line with SNS usage pattern, participants were mostly between 18 and 30 years of age in most studies included in the current review. While SNS use is most common among teens, usage has been growing among adults both under (Auxier & Anderson, 2021; Drouin et al., 2020) and over 65 years of age (Nimrod, 2020). The Coronavirus Disease 2019 pandemic also heightened the use of SNS and other online sources among adults, with increased SNS use being linked to enhanced quality of life among older adults (Wallinheimo & Evans, 2021). This increased usage combined with the motivation for using SNS highlights the opportunity to also expand SNS-delivered intervention research beyond teens and young adults.

The SNS that were used to offer health interventions varied based on the current review. Facebook was the most used platform for the interventions, but a significant number of interventions were provided on other commercially available SNS, including Twitter and YouTube. It's interesting to note that the majority of studies only used one SNS to deliver

interventions. The bulk of research that cross several platforms involve marketing initiatives that are being tested in ecologically valid context. This may indicate that marketing campaigns typically target a larger audience and that expanding the message's "reach" is important; this is in contrast to randomized trials where participants are enlisted before being exposed to the intervention. Even so, this highlights the importance of having an audience-centered or user-centered approach for the designing, developing, and testing of more engaging SNS interventions, focusing not only on a given platform's popularity but also on users' goals, preferences, and motivations for use.

While it is challenging to describe our findings about engagement due to the lack of agreement on what engagement for digital interventions is, as well as the dimensions and measures to best quantify it. The amount of views, comments on intervention posts, attrition rates, and online usage statistics supplied by SNS platforms were the most often used engagement metrics, which is an important result of this scoping review and complements other research. These metrics reflect how much a user has engaged with an intervention. Alternatively said, these are micro level engagement indicators (Short et al., 2018), which offer data on behavioral engagement with the intervention but less so on macro level engagement, or the user's cognitive and emotional engagement with the behavioral change process. Future SNS-delivered interventions must give more thought to evaluating both micro and macro level engagement given the significance of designing SNS-delivered interventions that produce positive effects via effective engagement (Yardley et al., 2016).

It is also worth noting that while commercially available SNS could reduce participant burden in terms of learning curve, some challenges are noted. For instance, Pechmann (2017) noted that they had designed the intervention to be delivered on Facebook, but ended up utilizing

Twitter instead due to the ease of data collection through application programming interface (API). In another instance, Buller (2022) noted that Facebook had a change in policy during the intervention where they stopped displaying views for posts in private Facebook groups with more than 250 members, leading to data collection challenges. To fully integrate health interventions in a SNS, academia-industry partnerships will likely be needed.

Limitation

Several limitations should be considered. The current review only included studies that utilized a commercialized SNS that the public has access to. Studies exist that utilized researcher-developed SNS platforms for health interventions and these researcher-developed platforms will have fewer restrictions in terms of functionalities and data collection. However, one major benefit of using commercially available platforms is the reduced learning curve of using the technology given that we are "meeting people where they already are". The focus on existing commercialized SNS in the current study represent an effort to synthesize findings from utilizing these platforms and associated challenges that may be unique to them. The current review is also limited to peer-review articles. It is possible that there are other lessons learned from real-world health campaigns or other health interventions programs that do not publish results in peer-reviewed journals. While the current articles provide some starting points toward understanding the role of engagement in SNS-delivered interventions, continuing collaboration with community members and industry stakeholders will be critical to drive the science of engagement forward when working with these commercially available platforms.

Conclusion

Social network sites are part of the social fabric and as such, they may be a promising venue to deliver interventions aimed at ameliorating health issues among vulnerable populations.

This scoping review provides an overview of the current state of SNS-delivered interventions that had considered engagement in some ways. Although the excitement to use SNS to deliver health intervention is palpable in literature with a growing body of research, heterogeneity exists in how engagement is assessed and operationalized, with the majority focusing on micro-level engagement. Advancing the science of SNS-delivered interventions will likely require complementary approaches that incorporate both micro and macro level engagement factors and utilize a variety of methodologies.

Tables and Figures
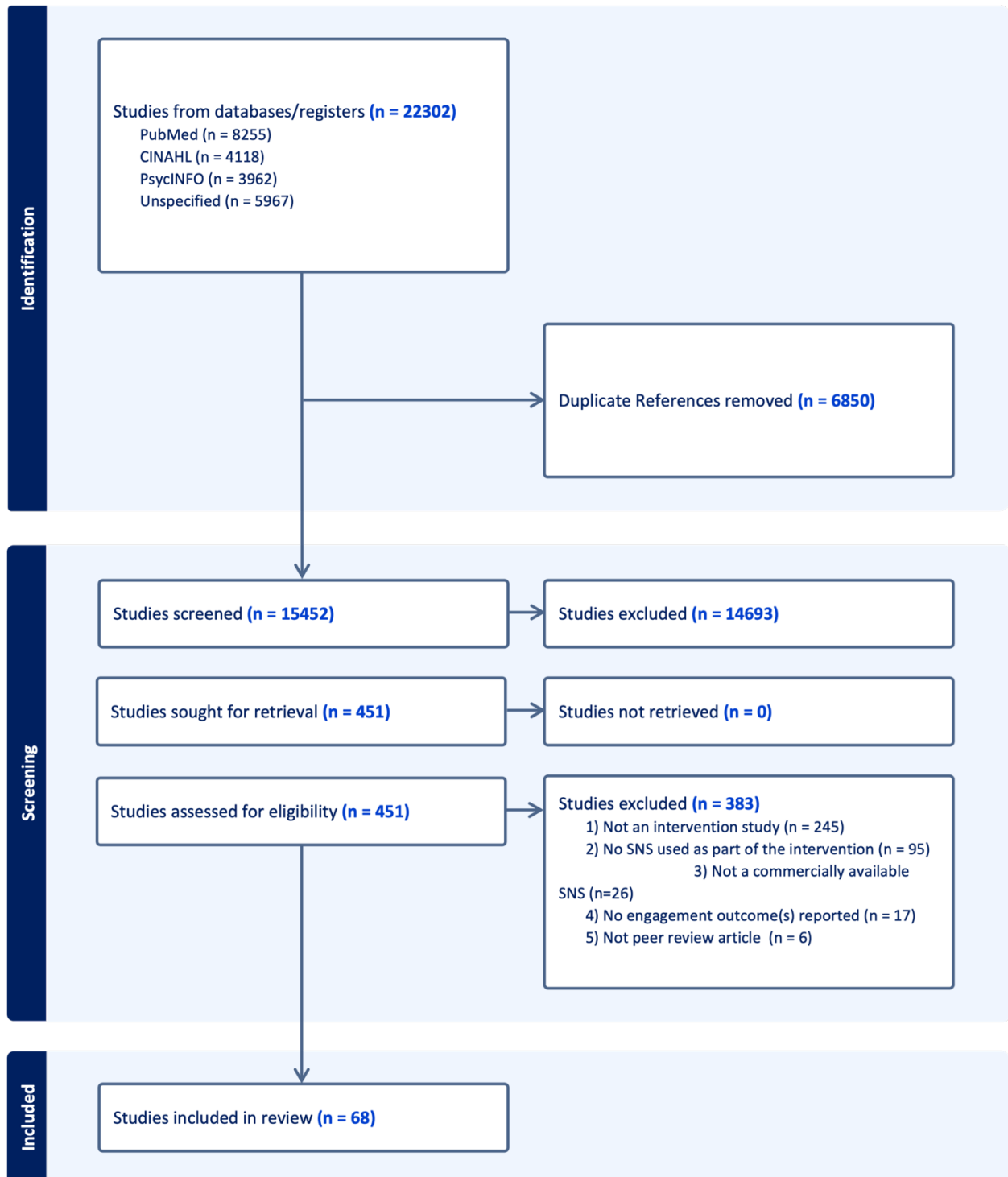
Figure 4.1: Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram for the scoping review process

Table 4.1: Characteristics of Studies on The Engagement Of SNS-Delivered Health Interventions

Author/Year	Country	Study Design	Study Type	Platform	N	Age Range, Mean	Race Ethnicity
Allen et al., 2020	US	Single Group Cohort study	Feasibility Trial	Twitter	35	18-26; 21.89	White: 14 Black: 51 Multi-racial: 9 Other: 20
(Anand et al., 2015)	Thailand	Other: Feasibility and Acceptability	Feasibility Trial	Facebook; YouTube; Other: Adam's Love	1181	14+; NR	NR
(Barragan et al., 2014)	US	Cross sectional study	Evaluative	Facebook; Twitter; YouTube	1041	18+; NR	Hispanics/Latino: 39.8 African American: 26.8 White: 14.2 Asian/Pacific Islander: 11 Other: 6.7
(Bonar et al., 2022)	US	RCT	Feasibility Trial	Facebook	149	18-25; 21.0	Black: 20.1 White: 70.5 Other: 9.4
(Bonnevie et al., 2020)	US	Cross sectional study	Evaluative	Facebook; Twitter; Instagram	782-800	18+	vary based on wave
(Bonnevie et al., 2022)	US	Cross sectional study	Evaluative	Facebook; Twitter; Instagram; YouTube	182	18-65; NR	vary
(Mayer & Harrison, 2012)	US	Quasi experimental study	Evaluative	Facebook	710	NR	NR
(Bull et al., 2012)	US	RCT	Efficacy Trial	Facebook	1578	16-25; 19.8 (intervention)	Black: 28.1 AI/AN: 0.7 Asian: 27.5 PI/Hawaiian: 1.1 White: 29.7 Other: 9.6

Table 4.1 (Cont.)

Author/Year	Country	Study Design	Study Type	Platform	N	Age Range, Mean	Race Ethnicity
(Buller et al., 2022)	US	RCT	Feasibility Trial	Facebook	869	18+; 43.13	white: 82.4 Hispnaic: 6.2 other: 11.4
(Cavallo et al., 2014)	US	RCT	Feasibility Trial	Facebook	67	NR; 20.35	White: 68.7 Non-White: 31.3
(He et al., 2017)	China	Quasi experimental study	Efficacy Trial	WeChat	15310	35.1	
(Cheng et al., 2020)	China	Cross sectional study	Evaluative	Facebook; YouTube			
(Curtis et al., 2020)	Australia	Single Group Cohort study	Feasibility Trial	Instagram	16	18-28; 23	NR
(Dulli et al., 2018)	US	RCT		Other: Study Website	1093		White: 87 Black: 2 Asian: 4 Other: 6
(Gamboa et al., 2019)	Other:	Single Group Cohort study	Feasibility Trial	Facebook	41	15-19; 17	NR
(Healy & Marchand, 2020)	Australia	RCT	Efficacy Trial	Facebook	444	41.3	NR
(Hughes et al., 2020)	Dominican Republic	RCT	Feasibility Trial	Facebook	37		
(S. H. Kim et al., 2022)	US	Single Group Cohort study	Feasibility Trial	Facebook	13 families (parent/child dyad)	41.3	White: 84.6 Asian: 7.7
(Lau et al., 2022)	US	Single Group Cohort study	Evaluative	Facebook	90	18-26	White: 47.8% Asian: 17.8% Black: 4.4% Hispanic: 23.3% Other: 6.7%
(Lawton et al., 2022)	South Korea	RCT	Feasibility Trial	Naver Cafe	89	49.34	NR
(Leahey & Rosen, 2014)	China	RCT	Feasibility Trial	Facebook	56	18-25	NR

Table 4.1 (Cont.)

Author/Year	Country	Study Design	Study Type	Platform	N	Age Range, Mean	Race Ethnicity
(Looyestyn et al., 2018)	US	Single Group Cohort study	Feasibility Trial	Facebook	30		White: 84% Hispanic: 4%
(Mancheno et al., 2021)	US	Single Group Cohort study	Evaluative	Facebook	39387	NR	NR
(Massey et al., 2022)	Australia	RCT	Feasibility Trial	Facebook	89	35.2	NR
(Meacham, Ramo, et al., 2021)	US	RCT	Efficacy Trial	Twitter	611	52	White: 57.1 Black: 37.5 Asian: 1.1 Hispanic: 1.5
(Mohanty et al., 2018)	West Africa	Quasi experimental study	Evaluative	Facebook; YouTube	1674	24	NR
(Nadarzynski et al., 2019)	US	RCT	Feasibility Trial	Facebook	179	22.1	White: 80.4
(Napolitano et al., 2021b)	US	Cross sectional study	Evaluative	Facebook	152	13-18	Black: 45 Hispanic: 25 Asian: 18 White: 3 Other: 9
(Oppezzo et al., 2021)	UK	Cross sectional study	Evaluative	Facebook			
(Ortiz et al., 2018)	US	RCT	Efficacy Trial	Facebook; Other: Text messaging	459	18-35, 23.3	White: 49.0 Black: 19.8 Asian: 9.4 Hispanic: 13.5 Other: 8.3
(Pagoto et al., 2022)	US	RCT	Feasibility Trial	Twitter; Other: Fitbit	45	59.7	White: 74 Black: 4 Asian: 13
(Pechmann et al., 2015)	US	RCT	Feasibility Trial	Facebook	108	15.6	White: 53.7 Black: 25 Hispanic: 9.2

Table 4.1 (Cont.)

Author/Year	Country	Study Design	Study Type	Platform	N	Age Range, Mean	Race Ethnicity
(Pechmann et al., 2017)	US	RCT	Feasibility Trial	Facebook; Twitter	66	24	
(Z. C. Pope et al., 2018)	US	Single Group Cohort study	Feasibility Trial	Twitter	40	20-57; 36.5	White: 95
(Z. Pope et al., 2019)	US	RCT	Efficacy Trial	Twitter	160	35.7	White: 88.7 Black: 6.9 Hispanic: 4.4
(Meacham, Liang, et al., 2021; Ramo et al., 2018)	US	RCT	Feasibility Trial	Facebook	30	50.6-54.9	White: 97 Hispanic: 3
(Ridgers et al., 2021)	US	Single Group Cohort study	Feasibility Trial	Facebook; Other: MapMyFitness App	12	21+, 45.8	White: 90 Asian: 10
(Rouf et al., 2020)	US	RCT	Efficacy Trial	Facebook	500	20.9	White: 73.8 Native American: 1 Black: 2.6 Asian: 1.2 Hispanic: 6.9 Mixed: 14.5
(Schoenfelder et al., 2017)	Australia	RCT	Efficacy Trial	Facebook	275	13.7	NR
(Silfee et al., 2018)	Australia	RCT	Efficacy Trial	Facebook	211	18-25; 21.4	NR
(Stapleton et al., 2018)	US	Single Group Cohort study	Feasibility Trial	Facebook	11	14-18; 15.5	White: 80 Asian: 10 Other: 10
(Sun et al., 2017)	US	Single Group Cohort study	Feasibility Trial	Facebook	16-27	29.4-32.1	
(Turner-McGrievy & Tate, 2013)	US	Single Group Cohort study	Feasibility Trial	Facebook	17	20.8	White: 53 Other: 29 Asian: 12

Table 4.1 (Cont.)

Author/Year	Country	Study Design	Study Type	Platform	N	Age Range, Mean	Race Ethnicity
(Vogel et al., 2019)	China	RCT	Efficacy Trial	Facebook	196	19-20	NR
(Sun et al., 2017)	US	RCT	Feasibility Trial	Twitter; Other: podcast	47	42.6	White: 75 Non-White: 25
(Waring et al., 2018)	US	RCT	Efficacy Trial	Facebook		18-25, NR	White: 73.8 Black: 2.6 Alaskan or Native American: 1.0 Asian: 1.2 Hispanic/Latino: 6.9 Multiple races: 14.5
(Watach et al., 2022)	China	RCT	Efficacy Trial	Facebook	196	17-24, NR	NR
(Young et al., 2013)	US	Single Group Cohort study	Feasibility Trial	Facebook	19	31.5	White: 74 Black: 5 Hispanic: 11 Asian: 11

Table 4.2: Engagement Characteristics Of SNS-Delivered Interventions for Improving Health Outcomes

Author/ Year	Health Topic	SNS Delivery	Non-SNS components	Program Length	Brief Intervention Description	Comparator Condition	Engagement Indicator	Main Findings
Allen et al., 2020	HPV	Full		1 month	Participant received daily tweet related to HPV, HPV vaccine and cervical cancer screening with materials adapted from CDC, NCI, and MA DOH.	NA	# of participants liked/ retweet posts # blocked account	Outcome: no significant pre-post differences in outcomes
(Anand et al., 2015)	HIV testing	Partial	study specific website	40 months	Adam's Love club membership provided HIV prevention information and resources, social media, message boards, online counseling, appointment making, entertainment, fashion, photography, and YouTube videos	NA	Analytics from Google, YouTube, and Facebook # of referral	Engagement: Adam's Love attracted 1.69 million viewers, had 8 million page views, average 4.6 min per visitor Outcome: Online-to-offline recruitment was able to successfully promote MSM HIV testing, HIV counseling, and referral to treatment
(Barragan et al., 2014)	Obesity	Partial	mass media, online interactive tool	14 months	Social marketing campaign that used a variety of paid media (e.g., billboard, bus display, poster, television) as well as social media channels (Facebook, Twitter, YouTube) to disseminate content related to obesity and sugar	NA	Facebook, Twitter, and YouTube interactions	Outcome: Women aware of the campaign reported significantly higher agreement that quality prenatal care can reduce the likelihood of having a low birthweight baby (Campaign Awareness: 71.7%, No Campaign Awareness: 51.4%, p= .039). Engagement: 63,000 Facebook interactions, 1.5 million Twitter impressions, 15,000 YouTube views

Table 4.2 (Cont.)

Author/ Year	Health Topic	SNS Delivery	Non-SNS components	Program Length	Brief Intervention Description	Comparator Condition	Engagement Indicator	Main Findings
(Bonar et al., 2022)	cannabis use	Full		8 weeks	Participants saw daily content related to cannabis use as part of a private Facebook group. Program staff also encouraged participation through sharing goals, pet pictures and other non-cannabis content.	Attention control that received content unrelated to substance use or mental health.	#posts/comments, #reactions, # total interaction enjoyment of different content formats (e.g., memes, quizzes, news article, videos) helpfulness with interaction with e-coaches and other participants	Engagement: intervention group displayed significant greater interaction compared to control in terms of posting, commenting and clicking reactions. Intervention group also rated highly of e-coaches and content. Outcome: Facebook page had the largest impact on improvement of food safety practice scores compared to no material control.
(Bonnevie et al., 2020)	sugar-sweetened beverages	Partial	in-person information sharing	10 months	Social marketing campaign that focused on sugar-sweetened beverages and its health effect. Local communities were engaged to post to their social media channels, and placing physical posters in community spaces.	NA	# of followers, impression, reach, total engagements	Engagement: Cumulative digital metrics across campaigns during the data collection period showed 1868 followers; 743,120 impressions; a reach of 384,772; and 10,675 engagements. Across all three campaigns, Facebook and Instagram received the most engagement from target audiences Outcome: Simple effects analyses for condom use showed that there was a difference between the intervention and control groups at the 2-month follow-up

Table 4.2 (Cont.)

Author/ Year	Health Topic	SNS Delivery	Non-SNS components	Program Length	Brief Intervention Description	Comparator Condition	Engagement Indicator	Main Findings
(Bonnevie et al., 2022)	maternal & child health	Full		9 months	Participant saw campaign content related to weight gain, prenatal care, reproductive empowerment, and COVID-19	NA	followers, reach, impression, total engagement	Engagement: garnered a total of 1,234 followers, with Instagram showing the highest number (889 followers), followed by Twitter (208 followers) and Facebook (137 followers). Across channels, there were a total of 805,437 impressions. There were a total of 12,827 engagements, with Instagram showing the highest number of engagements with almost twice the amount as those on Facebook and Twitter showing substantially less engagement.
(Mayer & Harrison, 2012)	food handling	Full		4 weeks	Participants saw videos related to food handling and food safety in a Facebook group. Staff also posted polls and status updates on the page to promote discussion.	in-person content delivery	enjoyment and interest in topic due to Facebook page	Engagement: Majority (~80%) in intervention group agreed they enjoyed learning about food safety in a social media format and more interested in food safety topics as a result of using the Facebook page.

Table 4.2 (Cont.)

Author/ Year	Health Topic	SNS Delivery	Non-SNS components	Program Length	Brief Intervention Description	Comparator Condition	Engagement Indicator	Main Findings
(Bull et al., 2012)	Sexually Transmitted Infection	Full		8 weeks	Participants were exposed to different sexual health topics for 8 weeks.	attention control	# visitor by topic; average time spent on site	Engagement: There were an average of 43 unique visitors per week with a range of 37-101. Average time spent on the Facebook page was 3.16 minutes. Outcome: The weight and waist circumference in the control group decreased by mean 1.78 (SD 2.96) kg and mean 2.39 (SD 3.91)cm, respectively, whereas in the WeChat group, weight and waist circumference decreased by mean 2.09 (SD 3.43) kg and mean 2.74 (SD 4.48) cm.
(Buller et al., 2022)	Indoor tanning	Partial	Email	12 months	Participants viewed daily posts from private facebook group about indoor tanning. Community manager monoitored comments and replied to misinformation. Participants also recevied email biweekly that highlight most popular post.	attention control Facebook group that focused on substance use	reaction, comment, post in feed, any indicator of engagement	Engagement: 68.2% of posts in the social media campaign received a reaction (e.g., like, sad, angry, etc.) and 53.8% received a comment from mothers. 66.9% of mother engaged at least once (mean = 19.59 [sd = 60.29] engagements per mother)

Table 4.2 (Cont.)

Author/ Year	Health Topic	SNS Delivery	Non-SNS components	Program Length	Brief Intervention Description	Comparator Condition	Engagement Indicator	Main Findings
(Cavallo et al., 2014)	Physical Activity	Partial	website	12 weeks	Participants had access to study website with physical activity materials and self-monitoring tool. They were also in private facebook group were financially incentivized to post original posts, as well as comments in group to interact with other participants.	Non-PA focused FB	#post made	Outcome: Feasibility: On average, participants reported seeing 6 out of the 7 posts per week in their Instagram feed. participants generally agreed that the program increased their motivation to exercise Engagement: Intervention participants who posted more than once (n=37) had on average 8.0 Facebook interactions during the intervention and there were 60 moderator posts.
(He et al., 2017)	Weight Loss	Full		6 months	Participants joined WeChat group to receive weight loss content, support, and participated in group-based competition. Counselor is avaiable to answer questions in the group.	no WeChat Group	# message read	Engagement: The messages were read more than 247,000 times and were sent to other WeChat accounts more than 6500 times.In total, 3620 participants communicated with others in‚Äúmicro community discussions‚Äù and there were more than 20,000posts.

Table 4.2 (Cont.)

Author/ Year	Health Topic	SNS Delivery	Non-SNS components	Program Length	Brief Intervention Description	Comparator Condition	Engagement Indicator	Main Findings
(Cheng et al., 2020)	Suicide Prevention	Full		26 weeks	Participants were able to view short film on YouTube after release.	NA	# of comments; public comment sentiment	Engagement: a total of 164 public comments on YouTube and two Facebook pages were collected. Among all comments, 70.3% expressed their appreciation to the production crew for producing a high-quality and meaningful short film; 18.9% were touched by the story and felt positive toward the film; 10.8% showed support to the people in distress. On the other hand, some comment-ers (5.4%) expressed their sadness and helplessness toward their situation and the issue of suicide
(Curtis et al., 2020)	Physical Activity	Full		3 months	Participants were part of a private Instagram page where they received daily content related to the exercise program, video demonstrations of exercises, and motivational content.	NA	# likes, #comments, # exercise session completed	Engagement: Daily posts received an average (median) of 5 likes (IQR = 3,Äì6) across the 12-week period. Likes were highest in weeks 2 and 3 and declined over the study period. There was a total of 4 comments and 1 tag across all posts. Outcome: Daily minutes of MVPA measured via accelerometry did not increase significantly from baseline to 3 or9 month follow up and no significant group X time interactions were found.

Table 4.2 (Cont.)

Author/ Year	Health Topic	SNS Delivery	Non-SNS components	Program Length	Brief Intervention Description	Comparator Condition	Engagement Indicator	Main Findings
(Dulli et al., 2018)	HIV	Full			Participants were part of prviate Facebook group where they received content related to HIV treatment adherence and participated in group discussions.	NA	#session attended, # read comments, posts, like, wrote comments or post questions enjoyment, comfortability	Engagement: Each group had 1-3 members who were considerably more active than the others. They enjoyed the intervention because it was educational or informative. They enjoyed sharing experiences, and communicating with other ALHIVs; it helped them take care of themselves and their health (eg, most commonly, taking drugs on time) and felt supported or encouraged.
(Gamboa et al., 2019)	Zika Virus	Full		3 month	Participants were part of Facebook group to receive arboviral prevention information.	attention control	#posts (e.g., comments, images, video), # views, # likes, # shares, # peers invited	Engagement: Differences were observed with a notably increased level of posting, distributing online materials, and higher numbers of passive vi of the content in Group 1 compared to Group 2. Subsequently, Group 1 had a statistically significant increase in survey knowledge scores (P<0.0001) and preventative behaviors in all categories (PBP P=0.0009, HVC P=0.0011, CVC P=0.0007) compared to Group 2.

Table 4.2 (Cont.)

Author/ Year	Health Topic	SNS Delivery	Non-SNS components	Program Length	Brief Intervention Description	Comparator Condition	Engagement Indicator	Main Findings
(Healy & Marchand, 2020)	Physical Activities	Full		4 weeks	Parents in the study join a private Facebook group and received physical activity related content for their child.	NA	#post seen; perception of Facebook components	Engagement: Moderator posts to the Facebook group page were seen, on average, by 76% of the participants. The majority of participants posted to the Facebook group (text, videos, and/or photographs) (n = 7, 53.8%), and participated in discussions with other participants in the group (n = 8, 61.5%) Feasibility: the majority of the intervention group (77.4% or 24 out of31) considered Facebook an effective way to enhance their PA behavior
(Hughes et al., 2020)	Human papillomavirus	Partial	in-person events and physical posters in community		Using university health center Facebook page, researcher distributed campaign materials notified followers about events and shared videos. Campaign posters were posted across campus. Student organizations were engaged for education campaign.	NA	Video views, # likes, # shares	Engagement: Students shared these videos 197 times and recorded over 17,000 views on Facebook. Varying level of views on different videos

Table 4.2 (Cont.)

Author/ Year	Health Topic	SNS Delivery	Non-SNS components	Program Length	Brief Intervention Description	Comparator Condition	Engagement Indicator	Main Findings
(S. H. Kim et al., 2022)	Diabetes	Full		6 months	Participants were in a Navar Café Group that were nurse-led. They received diabetes information, goal setting, and were able to ask questions or interact with others in the group.	Waitlist control	#visit, most used feature Motivation, feeling toward SNS feature	Engagement: The mean number of website visits per month was 8.53. And the revisit rates for each website section were as follows: 69.7% for diabetes in-formation, 67% for action planning, 45% for questions and answers, and 73.3% for free chatting. Patients expressed that nurses' professional advice was the most helpful component of the social media intervention. Outcome: Intention-to-treat analyses showed that players lost a significant amount of weight from baseline to the end of the game (P<.001)
(Lau et al., 2022)	physical activity	Full		1 month	Participants saw daily physical activity-related links and materials by peer captains in a Facebook page. They are also encouraged to share their experiences/feeings in the page.	no message control	positive emotion	Engagement: Motivation (supports from your friends) and tailored feedback were the top two features listed by the intervention group, whereas motivation, rewards and personal goals were the top three features in control group. Outcomes: There was a significant increase over time in MVPA in both the intervention and control groups (time effect P=.004).

Table 4.2 (Cont.)

Author/ Year	Health Topic	SNS Delivery	Non-SNS components	Program Length	Brief Intervention Description	Comparator Condition	Engagement Indicator	Main Findings
(Lawton et al., 2022)	Nutrition	Full		3 weeks	Participants in a Facebook group saw nutrition information 5 out of 7 days a week.	NA	#post, #likes, #comments #seens perceived social support	Engagement: Over the 3-week intervention period, the mean (SD) number of likes, comments, and votes per post were 9.6 (10.8), 6.6 (8.3), and 1.8 (1.2), respectively. About half of the participants (n = 12, 48%) reported visiting the Facebook group at least once a day, 8 (32%) reported that they visited multiple times per day. Outcomes: At 6 months the SBP was 135.7 mm Hg (SD, 16.9) for control and 137.6 mm Hg (SD, 18.3) for intervention (P=0.23)
(Leahey & Rosen, 2014)	Physical Activity	Partial	website	1 month	Participants join social gaming website DietBet that uses financial incentives to promote weight loss. They were encouraged to share their status on Facebook	NA	#share on FB, social interaction with other participants	Engagement: 50.03% of players chose to share their DietBet participation on Facebook Outcome: viewers of the series had 26% greater odds of answering pro-health responses about sexual assault, emergency contraception, and female circumcision correctly.

Table 4.2 (Cont.)

Author/ Year	Health Topic	SNS Delivery	Non-SNS components	Program Length	Brief Intervention Description	Comparator Condition	Engagement Indicator	Main Findings
(Looyestyn et al., 2018)	Physical Activity	Full		2 months	Participants in a private Facebook group received weekly interval training session. Group facilitator also post informational content, as well as polls and prompts to the group each day.	Self-directed running program	# time visited FB page, # total interaction Perceived support	Engagement: Six (19%) intervention participants reported visiting the Facebook group at least daily. The mean total number of interactions with the Facebook group was 34.7 (SD=40.7). In relation to participant-initiated posts, most agreed that the posts were supportive (69%), relevant (59%), and motivating(59%) Outcomes: Biochemically verified abstinence from smoking did not significantly differ between STAND and TSP at 3, 6, or 12 months in complete case or intent to treat analyses (all p >.05).
(Mancheno et al., 2021)	Hypertension	Full		6 months	Participants were asked to tweet or retweet health-related content twice per week as well as a study-designated hashtag.	Attention control (follow study account)	#tweets Tweet themes	Engagement: The intervention group posted 1646 tweets about health using the study-assigned hashtag (#health). These tweets included themes such as news (731; 44%), diet/nutrition (565; 34%), and heart health

Table 4.2 (Cont.)

Author/ Year	Health Topic	SNS Delivery	Non-SNS components	Program Length	Brief Intervention Description	Comparator Condition	Engagement Indicator	Main Findings
(Massey et al., 2022)	Sexual Health	Full		6 months	Participants viewed a telenovela series on sexual health and reproductive justice on Facebook and YouTube.	Non-viewers	# view Narrative engagement	Engagement: Level of engagement with specific storylines was associated with a differential impact on overall outcome questions, most notably with the storyline about emergency contraception
(Meacham, Ramo, et al., 2021)	Smoking Cessation	Partial	nicotine replacement therapy	90 day	Participants receive daily Facebook posts related alcohol and cigarette co-use and weekly live counseling sessions in a private facebook group. They also received a 14-day nicotine replacement therapy.	Tobacco-focused control	Cognitive: thought about the post and acted on it	Engagement: Intervention participants were more likely than control participants to agree that the intervention helped them to be healthier, that they used the information in the posts, and that they thought about what they read in the posts.The 24 participants with self-reported smoking abstinence at 3 months contributed significantly more comments (median = 90.5, IQR =35.5, 101.8) than did the 155 participants without self-reported abstinence at 3 months (median = 38.0, IQR = 6, 89) (p = .039).

Table 4.2 (Cont.)

Author/ Year	Health Topic	SNS Delivery	Non-SNS components	Program Length	Brief Intervention Description	Comparator Condition	Engagement Indicator	Main Findings
(Mohanty et al., 2018)	Human papillomavirus	Partial	website	1 year	Marketing campaingn on Facebook that redirect adolescents to study Facebook page and website. Participants could view study content and information about vaccine clincics. Study staff answers questions on Facebook page.	NA	reach, number clicked, liked, commented on, # followers	Engagement: Facebook page ran six sets of advertising campaigns, which, on average, reached155,110 adolescents, engaged 2107 adolescents per advertising campaign, and accrued more than 3400 unique fans over the course of the project.
(Nadarzynski et al., 2019)	Sexual Health	Full			Participants were exposed to GIF-based Facebook ads related to at-home chlamydia testing and were able to order testing kits.	NA	#reach	Engagement: Facebook advertisement reached 40,347 women and 37,292 men, of which 1400 women and1413 men interacted with the advert (3.6%) over the period of the intervention. Amongst those who interacted, 27% were between 13 and 17 years of age. The advertisement resulted in 2825 visits to the chlamydiatesting page out of 348,777 impressions of the advert

Table 4.2 (Cont.)

Author/ Year	Health Topic	SNS Delivery	Non-SNS components	Program Length	Brief Intervention Description	Comparator Condition	Engagement Indicator	Main Findings
(Napolitano et al., 2021b)	Physical Activity	Partial	text messages, email with updates	18 months	Participants received PA content on Facebook over 38 weeks as well as text messages, and weekly reports on progress.	general topic FB group	# of study component completed	Engagement: Among the subset of participants with high engagement at 6 (n = 137), 12 (n = 127), and 18 months (n = 114), global p-values for treatment group differences were p = .01 at 6 months, p = .06 at 12 months, and p = .33 at 18 months.
(Oppezzo et al., 2021)	Physical Activity	Partial	Fitbit/ app	3 months	Participants were encouraged to tweet in the private Twitter group daily to answer prompt or show support for others. They also received automated text messages providing feedback on their twitter activities. All participants received fitbit to self-monitor physical activitiy level.	No Twitter support control	# tweet	Engagement: Tweet engagement with the group decreased over time, but every participant tweeted at least once, with a total of 1304 tweets over the 13 weeks. Participants sent on average 54.8 (SD =35.4) tweets on 35.6 (SD =21.6) different days over the 13-week intervention. Proportions of those who evaluated components of the study as between somewhat helpful to extremely helpful were 65% for the daily prompts, 50% for reading the group posts, 45% for posting to the group themselves, and 42% for group interactions in general

Table 4.2 (Cont.)

Author/Year	Health Topic	SNS Delivery	Non-SNS components	Program Length	Brief Intervention Description	Comparator Condition	Engagement Indicator	Main Findings
(Ortiz et al., 2018)	HPV	Full		3 months	Participants saw within a Facebook page a variety of health topics, approximately half of which focused on HPV.		Facebook use (notification)	Engagement: Almost half of participants in the intervention group indicated they received a notification from the Facebook page every time a new fact was posted (n = 40, 48.8%).
(Pagoto et al., 2022)	Skin cancer	Full		4 week	Participants received information about sun safety and were asked to create up to 6 social media posts related to the topic on the campaign Facebook and Twitter page over a month.	Healthy lifestyle attention control	# of posts, # of reactions, unique user comments, share/retweets retention	Engagement: Retention was 100%. Most Healthy Skin participants (88%; n = 30) and Healthy Lifestyle participants (91%; n = 29) created at least one post, and 56% (n = 19) and 38% (n = 12) of participants in these conditions, respectively, created the maximum of 6 posts. 1.8% and 12.5% of Healthy Skin and Healthy Lifestyle participants shared their post on their Facebook page respectively, and 32.2% and 15.6%, respectively, retweeted on Twitter.

Table 4.2 (Cont.)

Author/ Year	Health Topic	SNS Delivery	Non-SNS components	Program Length	Brief Intervention Description	Comparator Condition	Engagement Indicator	Main Findings
(Pechmann et al., 2015)	Smoking Cessation	Full		100 days	Participants in a private Twitter group received daily automated messages related to smoking cessation. The messages also promote group bonding.			Engagement: Across the two groups, the total tweet volume was 2867 or anaverage of 72 tweets per group member; also 78% of the group members tweeted at least once. Auto messages generated 22.78%(653) of the tweets, while the remaining 77.22% (2214) of the tweets were spontaneous
(Pechmann et al., 2017)	Smoking Cessation	Partial	nicotine patches	100 days	Tweet2Quit participants received daily discussion topic auto messages and daily engagement auto feedback for 100 days, using fully automated program. Participants also received supply of nicotine patches.	No twitter comparison.	# posts Interest	Engagement: Three-quarters (60/80) of Tweet2Quit partici-pants tweeted at least once, and total tweets per group averaged1177 (SD=275, range=825,Äì1489). On average, eachTweet2Quit participant sent 58.8 tweet. Among Tweet2Quit participants, tweet volume related significantly to sustained abstinence (OR=1.02, CI 1.02 to 1.03,p<0.001), with each additional 10 tweets increasing the tweeter,Äôs odds of sustained abstinence by 20% on average. Tweet volume exhibited exponential decline over time.

Table 4.2 (Cont.)

Author/ Year	Health Topic	SNS Delivery	Non-SNS components	Program Length	Brief Intervention Description	Comparator Condition	Engagement Indicator	Main Findings
(Z. C. Pope et al., 2018)	Physical Activity	Partial	App	10 week	Facebook page used throughout the intervention to provide twice-weekly PA-related health education tips. They were also encouraged to post in Facebook group to support one another.	no smartwatch control	implementation of materials viewed, enjoyment	Engagement: 16 out of 20 participants enjoying health education tips, and participants across both groups reported implementing the tips provided 1.21.0 times/weekly
(Z. Pope et al., 2019)	Physical Activity	Partial	App	10 week	Facebook page used to provide twice-weekly PA-related health education tips for breast cancer survivor. They were also encouraged to post in Facebook group to support one another.	NA	# post, # read post	Engagement: Breast cancer survivors contributed 16 unique posts to this page. Of these 16 posts, 11 were statements regarding the workout(s) the breast cancer survivor(s) completed, four posts were uploads of tracking data. An average of 7.4 ¬± 0.9 of participants read each post. All breast cancer survivors recommended the combined MapMyFitness and Facebook intervention
(Meacham, Liang, et al., 2021; Ramo et al., 2018)	Smoking Cessation	Full		90 days	Participants were assigned private Facebook group based on their readiness to quit, and viewed posts related to smoking cessation strategies, and attended live counselor session.	Smokefree.gov website	Attrition, # comment	Engagement: Highest ratings were for ease of understanding the intervention (96%), thinking about what they read (92%) and believing the material gave sound advice (91%). 77% (n= 192) commented at least once to their Facebook group. 101 participants (40.6%) commented at least once during a live counseling session.

Table 4.2 (Cont.)

Author/ Year	Health Topic	SNS Delivery	Non-SNS components	Program Length	Brief Intervention Description	Comparator Condition	Engagement Indicator	Main Findings
(Ridgers et al., 2021)		Partial	Fitbit/ app; text messages	3 months	Participants in a researcher-moderated Facebook group received weekly missions to complete. They also could share experiences with other members and interact with research team on Facebook	Waitlist control	#view, #like, adherence to weekly challenge likability of FB, and weekly challenges, perceived impact on motivation, encouragement	Engagement: The majority of adolescents reported that the program was easy to understand, enjoyable; however, less than half liked the weekly challenges and Facebook videos. Males were significantly more likely than females to agree that they liked the Facebook pages and videos.
(Rouf et al., 2020)	nutrition	Partial	text messages	6 weeks	Participants received facebook posts or facebook posts+ text messages on calcium intake over 6 weeks.	pamphlet	#seen #likes #comments Ease of use	Engagement: For the Facebook plus text group, the mean number of repliesfrom participants was 3.8 out of a maximum 21 (range 1-18).Of 75 participants, 12 made no reply texts. The highest number of replies was to the yes/no response as towhether they had set a goal on the app (n=22). no differences between intervention groups as to ease of use, their liking, likelihood of recommending it to others, or usefulness of the program.

Table 4.2 (Cont.)

Author/ Year	Health Topic	SNS Delivery	Non-SNS components	Program Length	Brief Intervention Description	Comparator Condition	Engagement Indicator	Main Findings
(Schoenfelder et al., 2017)	Physical Activity	Partial	fitbit	4 week		NA	#viewed FB posts/updates, #posted in group, # posted in participant Facebook	Engagement: Participant engagement on FB varied, with 9-18% posted in Facebook group and 21%- 38% viewed FB posts and updates.
(Silfee et al., 2018)	Weight Loss	Partial		16 weeks	Participants received facebook posts related to weight loss in private Facebook group. Coach in the group liked and commented on posts to encouarge discussion and sharing strategies to deal with challenges.	NA	# post read	Engagement: On average, about 63% (17/27) women engaged in the group each week. Of the 24 women who completed the 16-week assessment, 71% (17/24) reported reading the entire intervention posts either most of the time oral ways and 42% (10/24) said that they read only part of the posts either most of the time or always. When asked about lurking, 1 woman reported never reading a post without commenting on it or liking it; 38% (9/24) women reported occasionally reading a post without commenting on it or liking it

Table 4.2 (Cont.)

Author/Year	Health Topic	SNS Delivery	Non-SNS components	Program Length	Brief Intervention Description	Comparator Condition	Engagement Indicator	Main Findings
(Stapleton et al., 2018)	Skin Cancer	Full		4 week	Participants viewed daily group posts about skin cancer.	NA	# view, # like	Engagement: Twelve out of seventeen participants (70.6%) viewed every post and an additional four (23.5%) viewed at least 75% of posts.An average of 91.4% participants viewed each post Posts were liked on average by 34.6% (SD 21.1) of participants. An average of 26.2% (SD 28.7) of participants commented on a typical post. Nearly half of participants (41.2%)commented within the webpages that were linked to in the homework posts. For participant-level engagement, participants, on average, liked 9.1 posts (SD 6.1) and commented on 7.6 (SD4.1). Participants provided favorable ratings on general intervention evaluation items including: interesting (mean 7.5 [SD 1.7]);understandable (mean 9.1 [SD 1.3]); useful (mean 8.2 [SD 1.7]);and positive (mean 9.1, [SD 1.5]).
(Sun et al., 2017)	Sexual Health	Full		6 weeks	Participants received sexual health related posts on Facebook. Peer educators were added to the group to moderate by posting questions and responding to comments.	Sexual Health website	Visiting Frequency Overall online experience	Engagement: intervention group have a significantly better online experience (Mi= 3.86 v Mc= 3.58, P<.001) and a significantly higher online-visiting frequency (Mi=3.53, Mc=2.47, P<.001) compared to the control group.

Table 4.2 (Cont.)

Author/ Year	Health Topic	SNS Delivery	Non-SNS components	Program Length	Brief Intervention Description	Comparator Condition	Engagement Indicator	Main Findings
(Turner-McGrievy & Tate, 2013)		Partial	podcast	3 Months	participants received study materials through podcast, and were told to read and post messages on Twitter delivered by study staff and other participants. Participants also used a diet and phsycial activity monitoring app.	podcast only	post to tweet social support felt	Engagement: There were a total of 2,630 posts to Twitter. From 0 to 3 months, the majorityof participants were active (64 %). From months 3 to 6, the majority was neither active nor consistently reading (55 %). The frequency of reported log-ons to Twitter also significantly decreased over time.
(Vogel et al., 2019)	Smoking Cessation	Full		12 months	Participants were part of a private Facebook group, based on their motivation to quit smoking, in which there were posts and live, online counseling sessions.	Non-SGM-tailored Facebook posts in private groups.	Number of Facebook comments during the 90-day intervention Perception of intervention	Engagement: Results showed that SGM (M = 42.85, SD = 45.31) and non-SGM (M = 32.66, SD = 41.20) participants did not significantly differ in number of comments posted (t[249]= -1.74, p = .08, d = .24). SGM and non-SGM participants did not differ in their perceptions of the intervention (p‚Äòs > .05)

Table 4.2 (Cont.)

Author/ Year	Health Topic	SNS Delivery	Non-SNS components	Program Length	Brief Intervention Description	Comparator Condition	Engagement Indicator	Main Findings
(Sun et al., 2017)	Sexual Health	Full		6 weeks	participants in private Facebook group viewed sexual health related posts. Participant notification were turned on. Peer educators posts questions and respond to comments in the group	website control	# visit to study page, experience with intervention, qualitative comments	Engagement: the evidence supports the hypothesis that the intervention group would have a significantly better online experience ($P<.001$) and a significantly higher online-visiting frequency ($P<.001$) compared to the control group. For the intervention group, 42% (5/12)of the comments were positive. Participants mentioned that the videos were funny, that some practical knowledge was provided,
(Waring et al., 2018)	Physical Activity	Full		12 weeks	Postpartum women who are overweight or obese received content through private Facebook group that focused on self-monitoring, social support, stress management, environmental restructuring. Clinical psychologist in group to provide support and encourage discussion in the group.	NA	# posts, # comments, # likes	Engagement: Over 12 weeks, participants posted a median of 2 original posts and 24 replies and liked a median of 32 posts or comments. Engagement was sustained through the end of the intervention: 42% of participants posted, commented, or liked a post or comment on the last day of the intervention, 63% during the last week, and 100% in the last 4 weeks.

Table 4.2 (Cont.)

Author/ Year	Health Topic	SNS Delivery	Non-SNS components	Program Length	Brief Intervention Description	Comparator Condition	Engagement Indicator	Main Findings
(Watach et al., 2022)	Sleep Apnea	Full		1 month	Adolescents and parents join separate private Facebook group and received tailored content related to sleep apnea, treatment adherence and sleep hygiene.	NA	semi-structured interview	Engagement: The intervention was perceived positively, with peer-support and a sense of community emerging as overwhelming favorited aspects of involvement
(Young et al., 2013)	HIV prevention	Full		12 weeks	Participants in private Facebook group interacted with peer leaders through posts in group and chats related to HIV prevention and testing. At-home HIV testing kit could be requested online	attention control (lifestyle FB group)	# Messages, wall post or chat	Engagement: participation was highest during the first period across all 3 activities. Participation and engagement was high across all 3 assessment periods for the intervention (95%, 91%, and 77%, respectively) and control(73%, 62%, and 55%, respectively) groups

Chapter 5:

Study 2 - Engagement as A Mediator of The Effectiveness of Framed HPV Vaccination Promotion Messages on Instagram Among College Students: A Randomized Experiment

Abstract

Purpose: Scholars have argued that gain-framed messages should be more effective for prevention behaviors while loss framed messages should be more effective for detection behaviors. However, evidence for this taxonomy has been mixed for vaccination. This study aimed to examine if 1) the effects of message framing (i.e., gain/loss) on vaccination intention and 2) whether affective engagement (i.e., positive emotion), cognitive engagement (i.e., elaboration) and behavioral engagement (e.g., liking post) mediate the effect of exposure to a framed Instagram post on HPV vaccination and intention to vaccinate among college students.

Methods: An online randomized experiment was conducted in November 2022. College students (N=528) ages 18-26 that had not started the HPV vaccination series were recruited through Qualtrics. ANCOVA was used to test for main effect of message framing and mediation analyses were conducted using PROCESS macro.

Results: Gain-framed message was more effective than loss-framed message in increasing HPV vaccination intention, but neither was better than the knowledge-only control. Mediation analysis indicated that the relative advantage of gain-frame messages (vs. loss-framed message) was partially mediated through positive emotion evoked in participants.

Conclusion: Results of the study support the taxonomy of prevention-detection framework and the feasibility of disseminating HPV vaccination information to college students through Instagram using a message framing strategy.

Introduction

Human papillomavirus (HPV) is the most common sexually transmitted infection (STI) in the United States (US), with the highest infection rates occurring among college-aged populations, those in their occurring in college-aged individuals (i.e., late teens and early 20s). Infection with HPV can cause genital warts and persistent infection with specific strains (e.g., type 16 and 18) potentially leading to anal, cervical, oropharyngeal, penile, vaginal, and vulvar cancers (Saraiya et al., 2015). However, the HPV vaccination (i.e., GARDASIL 9) is available and can prevent most cases of genital warts and HPV-related cancers (Kirby, 2015). Despite its effectiveness, HPV vaccination uptake remains suboptimal in the US, with only 58.6% of US adolescents from ages 13-17 being up-to-date with the vaccine series in 2020. The U.S. Centers for Disease Control and Prevention (CDC) Advisory Committee on Immunization Practices (ACIP) recommends HPV vaccination for all individuals up to the age of 26 who were not vaccinated as an adolescent (*HPV Vaccine Schedule and Dosing | CDC*, n.d.), suggesting an opportunity for catch-up vaccination among young adults (those aged 18-26 years), many of which are likely to be current college students. Presently, HPV vaccination uptake among young adults remains low, with 40% having initiated the vaccine series and only 21% having completed it (Boersma & Black, 2020). As such, greater efforts targeting the young adult population is sorely needed as part of the comprehensive strategy to increase HPV vaccination uptake and prevent its associated health consequences.

Colleges serve as an ideal location to vaccinate young adults against HPV. In the US, 74% of 4-year colleges provide access to the vaccine for students between ages 18 and 26 (Habel et al., 2018) and the majority of college students (95.7%) reported having health insurance (American College Health Association, 2020), making the HPV vaccine financially accessible

for this population. A recent study suggests social network sites (SNS), which primarily utilize graphics and videos (e.g., Instagram, YouTube) – as opposed to just text – are the preferred channels to receive HPV information among college students (Koskan et al., 2021). However, few studies have tested the use of SNS for HPV vaccination information delivery (Brandt et al., 2020; Chodick et al., 2021; Sundstrom et al., 2021); of those, those that have often utilized SNS platforms decreasing in popularity among young adults (e.g., Facebook), largely failing to take into account the increasing preference among young adults for other already popular (e.g., Instagram) and newly emerging SNS platforms (e.g., TikTok). Building on this evidence base, this pilot study tested the feasibility of delivering HPV vaccination promotion information to young adults through Instagram in the context of a college campus.

Gain and Loss Framing

The messaging used in the current study was informed by Rothman and Salovey's application of the Prospect Theory (Rothman & Salovey, 1997; Tversky & Kahneman, 1981). According to Prospect Theory, individuals are more risk-seeking when they are faced with a decision under the conditions of risk (i.e., loss) and are more risk-averse when they are confronted with a decision under the conditions of little risk (i.e., gains). As such, Rothman & Salovey suggested that health messages can be framed to highlight either the benefits of engaging in a particular behavior (a gain-frame) or the consequences of failing to engage in a particular behavior (a loss-frame). This simple variation in how health information can be framed is important because research has shown that although often conveying essentially identical information, one type of message frame may be more effective than another at promoting health behavior change (Gallagher & Updegraff, 2012; Rothman & Salovey, 1997). In general, gain-framed messages are more effective for behaviors that are perceived as more

preventative or health-promoting, such as getting vaccinated or quitting smoking. Loss-framed messages may be more effective for behaviors that are perceived as more risky or disease-focused, such as getting screened for STIs.

In the context of vaccination, it is hypothesized that gain-frame messaging would be more effective compared to loss-frame messaging. However, a recent systematic review of message framing in vaccine communication indicated there are inconclusive findings regarding the effects of message framing (O'Keefe & Nan, 2012). Some studies have reported a loss-framed advantage over a gain-framed message (Abhyankar et al., 2008; Gerend et al., 2008; Nan, 2012; Van'tRiet et al., 2014). Given the mixed results in the literature regarding the main effects of messaging framing on vaccination, we ask:

Research Question 1: Will participants who are exposed to gain-framed messages demonstrate greater vaccination intentions to receive the HPV vaccine compared to participants in the loss-framed, and control conditions?

Engagement as a Mediator

The use of online social networks to deliver behavioral interventions is an exciting development in recent years, but the underlying mechanisms conferring benefits from such interventions remains largely unknown. Studies have suggested that engagement is a necessary precondition for behavioral change in the context of a digital intervention. Maher and colleagues (2014) suggest the majority of SNS-based interventions may reach only 5-15% of program fidelity, suggesting participants only engaging with approximately 10% of intervention materials. Other studies have also found that intervention effects were only observed among participants who were highly engaged in the intervention, providing further evidence for the importance of engagement. Perski et al. (2017) have proposed that engagement in the context of a digital

intervention has two components: (1) the *extent* (e.g., amount, frequency, duration, depth) of usage and (2) a *subjective experience* characterized by attention, interest and affect. This multidimensional operationalization accounts for not only the micro behaviors (e.g., number of likes, comments, shares) that one may perform on a given platform, but also the macro level factors, such as cognition and affect, that have been shown to influence behavioral attitudes and intentions. In essence, the concept of engagement in digital interventions is not limited to mere user activity, but also encompasses the psychological aspects that underpin user behavior on those platforms.

In order to effectively influence someone through a message on SNS, it is important to consider cognitive engagement, which refers to the level of attention and consideration given to the message by the individual. The Elaboration Likelihood Model (ELM; Petty and Cacioppo 1986), suggests that when a message is deemed unimportant to an individual, they are less likely to pay close attention to it, and vice versa. Therefore, the amount of cognitive effort an individual puts into processing a message can greatly impact the message's ability to persuade them. This idea is supported by Rothman et al.'s interpretation on messaging framing, which suggests that individuals who are highly invested in a particular topic tend to process messages in a biased and elaborative way, favoring frames that are consistent with their beliefs and behaviors (such as gain-prevention or loss-detection). As such, the success of a persuasive message on SNS should be mediated through the level of cognitive engagement of an individual.

The role of emotion and affective states in explaining message framing effects has also been receiving more attention in recent years. Nabi's emotions-as-frames model (EFM) (Nabi, 2003) conceptualizes emotions as a potential mediator through which message stimuli will be interpreted, resulting in emotion-consistent decisions and actions. In a meta-analytic review of

affective dimension of gain and loss framing (Nabi et al., 2020), Nabi et al. found that across 25 articles (N = 5,772), gain-frame messages induce more positive emotions (d = 0.31, p=.02) and loss-frame messages induce more negative emotions (d= 0.18, p=.045). And the experience of emotions in turn enhances the effects of gain and loss framing, suggesting emotional responses to framed messages may offer a sensible pathway through which messages influence behavioral outcomes. This finding is also consistent with how engagement is currently being operationalized, where emotional engagement in a digital intervention is hypothesized to influence behavioral outcomes.

In the context of behavioral engagement, focus has been placed on the micro behaviors (e.g., liking, sharing, commenting) one can perform on social media. For example, Rus and Cameron (2016), in their analysis of health communication within diabetes-related Facebook pages, found that specific message features (e.g., imagery, sentiment, presence of social support, use of links) stimulate different forms of engagement. However, it is not as well known whether those micro engagements lead to behavioral change. Most recently, Leader et al. (2022) tested a narrative-based HPV communication strategy on Instagram with a group of young women ages 18-26 and found that higher video engagement was associated with stronger behavioral intention to talk to a physician, family/friends, and to vaccinate, providing some evidence that engaging information on SNS can lead to greater behavioral intention.

In line with the engagement definition proposed by Perski et al., the current study examines the role of message framing in generating macro (i.e., cognitive, and affective processing) and micro (i.e., liking, sharing, commenting) engagement and subsequently vaccination intention with communication messages on Instagram. A summary of our hypotheses is depicted in Figure 1 and we hypothesize the following:

Hypothesis 1 (H1): Gain frame (vs. loss frame) will have an indirect effect on vaccination intention through cognitive engagement of the post.

Hypothesis 2 (H2): Gain frame (vs. loss frame) will have an indirect effect on vaccination intention through emotional engagement (i.e., positive emotion) of the post.

Hypothesis 3 (H3): Gain frame (vs. loss frame) will have an indirect effect on vaccination intention through behavioral engagement (i.e., liking, sharing, commenting) of the post.

Hypothesis 4 (H4): Gain frame (vs. loss frame) will have an indirect effect on vaccination intention through cognitive/emotional engagement and behavioral engagement in serial.

Methods

Participants

This study was approved as exempt by University of Arkansas Institutional Review Board (Protocol #2209423585). College students (N=528) were recruited from an online panel through Qualtrics from November 2022 through March 2023. Eligible participants had to be between ages 18-26, currently enrolled in a university within U.S., and using Instagram at least once a day. Eligible participants who have had initiated the HPV vaccination were excluded. Additionally, participants who did not answer the attention check question correctly or were speeding through the survey (defined as spending less than half of the median time to complete the survey) were excluded.

Procedure and Materials

This study utilized a two-factor (frame: gain/loss; endorsement: high/low) between subjects design, with a separate knowledge-based informational HPV vaccination promotion message control group. Respondents were invited to participate in a study evaluating health messages adapted for SNS. After providing consent, the participants completed a pretest

assessing baseline vaccination intention and demographics. They were then randomly assigned to a condition, exposed to stimuli, and directed to the posttest. On average, participants took a median of 11 minutes 29 seconds to complete the study.

Message stimuli used in the study is found in Appendix 1. The stimuli message utilized Instagram carousel, which is a post with up to 10 images or videos (Shel & Tien, 2022). Instagram users can view carousel posts by swiping left or clicking on the arrow button. The stimuli were embedded in the survey using an application programming interface (API). The participants were able to interact with the post as if they were on Instagram (i.e., to swipe). Message creation was informed by previous studies related to HPV vaccination promotion (Gerend et al., 2008; Gerend & Shepherd, 2007). Stimuli had approximately 160 words in the images and 50 words in the caption, and the Flesch-Kincaid reading level was rated 5.7 (or sixth grade). The control message had five images that focused on knowledge related to HPV and HPV vaccine, and a cue to action to make an appointment to get vaccinated. The gain and loss frame conditions had six images, including the five from control condition and one additional image that featured the reasons/consequences related to getting or not getting the HPV vaccine.

Measures

Measures for this study were collected at two timepoints, baseline and immediately after message stimuli exposure.

The primary outcome variable was *HPV vaccination intention.* This was measured at both time points by asking participants to rate the following 2 statements: "I plan to initiate the HPV vaccination series in the next 6 months" and "I plan to make an appointment to get the HPV Vaccine in the next 6 months" on a 5-point scale (1= strongly disagree; 5= strongly agree).

The two items are averaged to create a composite vaccination intention measure (Cronbach alpha = .95).

Cognitive engagement with the stimuli was adapt from Hong and Hashimoto (2021) and assessed with four 5-point questions (1= not at all, 5 = very much) by asking how much did the HPV vaccine message make them: 1) think about arguments for getting vaccinated for HPV? 2) think rather than feel 3) think about the consequences of vaccination that were mentioned in the message and 4) think about how getting HPV vaccination might affect your life. The four questions were averaged and combined into a composite cognitive engagement measure (Cronbach alpha =.85)

Emotional engagement was measured by asking if the message stimuli made participants felt a particular discrete positive emotion (i.e., happy, encouraged) on a 5-point scale (1=None of this feelings, 5=Great deal of this feeling). The two items were combined into one composite positive emotion score (Cronbach alpha = .71)

Behavioral Engagement was measured by asking how likely the participants were to interact with the Instagram message stimuli in the following ways on a 5-point scale (1=very unlikely, 5= very likely): 1) "Like" the post, 2) "Comment" on the post, 3) "Share" on Instagram story, 4) "Share" on Instagram story for close friends only, 5) "Share" privately through direct messages, and 6) "Share" through other channels (e.g., text messages, Facebook). Items 3-6 were averaged to create a composite measure for "share" (Cronbach alpha = .91)

Vaccine hesitancy was assessed by using the adult Vaccine Hesitancy Scale (aVHS) (Akel et al., 2021), which has 10 statements on a 5-point scale (1= strongly disagree, 5 =strongly agree). Example items include 1) Vaccines are important for my health, 2) Generally, I do what my doctor or healthcare provider recommends about vaccines for me, and 3) I am concerned

about serious adverse effects of vaccines. Three items were reversed coded. The 10 items were combined into composite score (Cronbach alpha = .86) ranges from 10-50, where a higher score indicating higher vaccine hesitancy.

Message comprehension was assessed by asking the participants "How difficult or easy was it for you *to read* the HPV vaccination message" and "How difficult or easy was it for you *to understand* the HPV vaccination message" on a 5-point scale (1= extremely difficult, 5 = extremely easy).

Past sexual activity was asked using a single-item "Have you ever had any kind of sex (e.g., oral, vaginal, anal) with any sexual partner? (yes/no).

Framing Manipulation Check was assessed by asking participants' perception related to the consequences of getting or not getting HPV vaccinated. The participants were asked to rate two questions on a 7-point scale (1= strongly disagree, 7 = strongly agree): "The HPV vaccination message I read highlighted the good things that could happen if I get vaccinated for HPV" and "The HPV vaccination message I read highlighted the bad things that could happen if I don't get vaccinated for HPV."

Demographics characteristics were measured in the study, including age, sex (male/female), race (White, Black, Other), ethnicity, years in college, and zip code prior to college.

Statistical Analyses

Chi-square and ANOVA were utilized to examine between group differences of participant characteristics to determine whether randomization was successful. For manipulation check, ANOVA was used to determine whether there were significant differences by condition. To test main framing effects on vaccination intention, analysis of covariance (ANCOVA) was

used on the posttest vaccination intention, utilizing pretest vaccination intention as a covariate. We also included known factors (i.e., vaccine hesitancy, and previous sexual experience) that influence vaccination decision making to increase the rigor of the analysis. Mediation analyses were conducted utilizing the Version 4 of PROCESS macro (Hayes, 2022) on SAS 9.4 (Cary, NC). This macro was used to estimate message framing direct and indirect effects on HPV vaccination intention through the hypothesized mediators. Indirect effects were estimated using a nonparametric bootstrapping procedure (n=10,000) to yield the bootstrap 95% confidence interval while controlling for covariates.

Results

Participant Characteristics

Participant (N=528) characteristics are presented in Table 1. We randomized 172 participants in the gain-frame condition, 183 participants in the loss-frame condition and 173 in the control group. Participants were on average 21.76 (SD 2.30) years old, mainly female (55%), non-Hispanic White (37%), in their first year of college (36%) and from the South within the U.S. (45%). The majority of participants reported engagement in any sexual activities in the past (73%), had an average of 35.05 (SD=7.14) in vaccine hesitancy based on the Adult Vaccine Hesitancy Scale (range 10-50), and had a baseline average of 2.75 (SD=1.12) HPV vaccination intention (range 1-5). No differences in participant characteristics were observed between groups, suggesting randomization success.

Manipulation Check

Responses to the loss frame manipulation check were significantly different between participants in the gain condition (M=5.16, SD=1.68) and loss condition (M=5.58, SD=1.43), t(353)= -2.51, p=.013. The difference between gain condition (M=5.64, SD=1.34) and loss

condition (M=5.56, SD=1.34) for the gain frame manipulation check was not statistically

significant, although the means were in the expected directions, $t(354) = .57$, ns. No significant

difference was found between the gain condition (M=4.32, SD=0.86) and loss condition

(M=4.35, SD=0.80) in terms of whether the message stimuli was easy or difficult to understand.

Main Effects of Framing on Vaccination Intention

The first analysis examined the effectiveness of exposure to a framed HPV vaccination

promotion message condition relative to a control message. Table 2 summarizes the results from

ANCOVA examining post-test intentions by condition, with pre-test vaccination intention,

vaccine hesitancy, and past sexual experience as covariates. These analyses demonstrated a

significant main effect for condition ($F(2, 521) = 3.03$, $p < .049$; $\eta p2 = 0.011$). Pairwise

comparison with Tukey-Kramer adjustment demonstrated significant difference between gain

and loss conditions (gain M = 3.32, SD = .058; loss M = 3.12, SD = .059, $p = .04$), but no

significant effects between gain and control (control M = 3.19, SD = .059, $p = .23$) and between

loss and control ($p = .73$).

Multiple Mediation Analyses

The results of the mediation models with gain-loss framing (n=355) are shown in Figure

1 (direct effects) and Table 3 (indirect effects). Overall, the results suggest that the observed

effect of gain frame (vs. loss frame) was partially mediated by positive emotion experienced by

the participants. H1 predicted that the effect of framing condition on vaccination intention will

be mediated through cognitive engagement. The mediation path through cognitive engagement

comparing gain and loss framing was not significant ($\beta= -0.046$, SD = .091, *ns*), and thus H1 was

not supported.

H2 predicted that the effect of the framing condition on vaccination intention will be mediated through the positive emotion experienced by the participants. In all mediation models, all mediation paths through positive emotions were significant; therefore, H2 was supported.

H3 predicted that the effect of the framing condition on vaccination intention will be mediated through the micro behaviors performed by the participants. In all mediation models, there was no evidence that intention to perform any types of micro behaviors (i.e., liking, sharing, commenting) on Instagram to mediate the relationship between messaging framing and vaccination intention; therefore, H3 was not supported.

Lastly, H4 predicted that the effect of framing condition on vaccination intention will be serially mediated through cognitive, emotional engagement and behavioral engagement. In one of the mediation models (i.e., intention to "like" the post), we found that the effect of framing condition on vaccination intention was partially mediated through positive emotion and intention to "like" the post in serial (indirect effect = .0083, SE = .0055, $p<.05$). However, this effect was not observed with micro behaviors related to "sharing", or "commenting". As such, H4 was partially supported.

Discussion

The results of this study provided evidence that it is feasible to deliver HPV vaccination promotion messages through Instagram. Study results suggest gain-framed HPV promotion messages had a relative advantage over loss-framed messages. However, neither performed better than the knowledge-based control message. Additionally, the study found that the relative advantage observed of the gain-framed condition over the loss-framed condition was mediated through positive emotion evoked in participants.

Although the effect of the messages was not mediated through cognitive engagement, the study findings also suggested that messages that are processed more deeply (i.e., higher cognitive engagement) strongly predict higher vaccination intention. With an abundance of competing information on SNS, the use of Instagram carousel post in the current study may be a practical strategy for disseminating information that promote cognitive engagement. Given that a carousel post can host up to 10 images and videos, practitioners can break down information into bite-size chunk to reduce information processing burden. Future studies may consider other factors that optimize cognitive and affect engagement with the intervention messages.

In the current study, the gain-framed condition did not outperform the knowledge-only control condition. This indicates that, for at least a portion of college students, having knowledge alone may be enough to prompt actions regarding HPV vaccination without the additional framed information. The Health Information National Trends Survey (HINTS) found that only about 60% of US adults have heard of HPV or the HPV vaccine in 2018, and there is a decline in awareness of HPV and the HPV vaccine among the general U.S. population since 2008 (Chido-Amajuoyi et al., 2021). Efforts in increasing awareness and knowledge of HPV and the HPV vaccine among the US adult population are needed.

Given the polarized nature of vaccination in the U.S., vaccination promotion interventions are at risk of boomerang effects (Nyhan et al., 2014), where participants may adapt the opposite attitude or behaviors of what the intervention advocate. In the context of the current study where participants had varying levels of vaccine hesitancy, we observed that there was a net positive increase in vaccination intention for all conditions, suggesting that both message framing or a knowledge-only post may be a feasible approach that did not induce boomerang effects in this population.

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Despite the emphasis of engagement on SNS in the literature, we found little evidence of performing micro-behaviors (i.e., liking, sharing, commenting) on Instagram to explain one's HPV vaccination intention. Instead, the study found that participants' cognitive and affective engagement with the post strongly predicts vaccination intention. Given the fact that the majority of SNS users are considered "lurkers," or users that only consume information and scrolling through their content feeds without engaging with the content or other users (Nielsen, 2006), this suggests that researchers need to be cautious when utilizing engagement metrics (e.g., likes, shares) available through SNS as an intermediate outcome for subsequent behavioral change. For instance, someone who is engaged cognitively and affectively engaged with the materials may still choose to not like, share, or comment on a post on SNS due to normative pressure or social desirability issues. Vice versa, participants may share a post because they found the post humorous, but it may not reliably predict that they actually agree with the post content or processed the post content.

It is worth noting that although our study did not find performing micro behaviors on Instagram to predict vaccination intention, performing those behaviors could have implications for the reach and spread of information on social network sites. Our mediation models suggested that emotional engagement with the material strongly predicts participants' intention to engage in micro behaviors on social networking sites. Previous research has indicated that features (e.g., imagery, sentiment, humor) that are likely to influence affect will also increase those micro engagement on SNS (Rus & Cameron, 2016). In the context of an intervention targeting a specific community (such as a college campus), tapping into emotional engagement through the materials may expand the reach to participant's social circle who may also need vaccination promotion materials. Future studies may benefit from further examining the types of post

features that may influence affective processing of vaccination information, and its subsequent impact on vaccination uptake.

Strengths & Limitation

The study had considerable strengths, including the relatively large sample size. A previous meta-analysis has shown that communication studies that framed vaccination information had only an average sample size of N=130, which could undermine the statistical power to detect effects (O'Keefe & Nan, 2012). The current study was also robust in including known covariates that can influence HPV vaccination intention, including baseline vaccination intention, vaccine hesitancy, and past sexual activities, which improves the rigor of the findings.

Although this study was carefully designed, it is subject to a number of limitations. In order to preserve the integrity of the stimuli for every participant, participants weren't able to comment, share or like as part of the experiment. Instead, we measured their intention to perform those micro behaviors. Observing bi-directional interactions of those features common on social networking sites would be a fruitful future research area where health communication interventions are implemented in a natural setting. Additionally, it is also plausible that the effect sizes reported are underestimated because of the single exposure utilized in the current study. In a media environment where framed information is abundant, future studies may consider longitudinal design with multiple exposure to improve external validity of the findings.

Conclusion

This study supports the feasibility of utilizing Instagram to deliver HPV vaccination information in the context of a college campus. We demonstrated that there is a gain-frame advantage over loss-frame on vaccination intention, and that the effect observed was partially mediated through positive emotion experienced by the participants. Our study findings address

gaps in the literature to help inform the design of successful social networking site-based interventions to deliver vaccination communication through emotional, cognitive, and behavioral pathways.

Tables and Figures

Table 5.1: Characteristics of Study Sample by Experimental Condition (n=528)

Characteristics	Total (n=528)		Gain (n=172)		Loss (n=183)		Control (n=173)	
	N	%	N	%	N	%	N	%
Demographic Variables								
Age, M(SD)	21.76	2.30	21.64	2.34	21.87	2.26	21.77	2.30
Sex								
Male	238	45%	81	47%	77	42%	80	46%
Female	290	55%	102	59%	95	52%	93	54%
Race & Ethnicity								
White, Non-Hispanic, Latinx or Spanish	196	37%	65	38%	67	37%	64	37%
Black/African American, Non-Hispanic, Latinx or Spanish	118	22%	46	27%	35	19%	37	21%
Other, Non-Hispanic, Latinx or Spanish	47	9%	15	9%	16	9%	16	9%
Hispanic, Latinx, or Spanish Origin	167	32%	57	33%	54	30%	56	32%
Years in College								
1st year	189	36%	64	37%	51	28%	74	43%
2nd year	183	35%	67	39%	61	33%	55	32%
3rd year	85	16%	25	15%	35	19%	25	14%
4th year	53	10%	18	10%	20	11%	15	9%
4th year +	18	3%	9	5%	5	3%	4	2%
Census Region Prior to College								
Northeast	108	20%	32	19%	39	21%	37	21%
Midwest	93	18%	29	17%	32	17%	32	18%
South	236	45%	90	52%	75	41%	71	41%
West	85	16%	31	18%	23	13%	31	18%
Variables Related to HPV Vaccine Information Processing								
Vaccine Hesitancy (Range 10 - 50), M(SD)	35.05	7.14	34.59	7.27	35.19	7.06	35.41	7.09
Had ever engaged in any sexual activities	388	73%	126	73%	135	74%	127	73%
Baseline HPV Vaccination Intention (Range 1-5), M(SD)	2.75	1.12	2.75	1.16	2.74	1.08	2.75	1.14

Note: Test for variance across conditions; continuous variables analyzed using one-way ANOVA test, categorical variables analyzed using Chi-square test.

Table 5.2: Analysis of Covariance (ANCOVA) results (n=528)

Variables	Pre-Test		Post-Test					Pairwise Comparison (p-value)		
	M	SD	M	SD	F	η^2	p-value	Gain v Loss	Gain v Control	Loss v Control
Intention to Vaccinate										
Gain	2.75	1.16	3.31	1.21						
Loss	2.74	1.08	3.12	1.10	3.03	0.005	0.049	0.017	0.102	0.450
Control	2.75	1.14	3.20	1.10						

Note: Covariates included baseline vaccination intention, vaccine hesitancy, and previous sexual experience. Pairwise comparison was conducted using Tukey-Kramer adjustment.

Table 5.3: Total and Indirect Effects of the Mediation Analyses (n=355)

	Beta	SE	p	LLCI	ULCI
Total Effects					
GainLoss Framing -> Vaccination Intention	0.203	0.081	0.013	0.043	0.363
Model 1 - Through cognitive engagement, affective engagement, and intention to "like" post					

Indirect Effects		Effect	Bootstrap SE	Bootstrap LLCI	Bootstrap ULCI
GainLoss Framing -> Cognitive Engagement -> Vaccination Intention		-0.0128	0.0265	-0.0659	0.0379
GainLoss Framing -> Positive Emotion -> Vaccination Intention		**0.0344**	**0.0198**	**0.0026**	**0.0790**
GainLoss Framing -> Intent to "Like" Post -> Vaccination Intention		-0.0150	0.0141	-0.0453	0.0108
GainLoss Framing -> Cognitive Engagement -> Intent to "Like" Post -> Vaccination Intention		-0.0012	0.0027	-0.0067	0.0043
GainLoss Framing -> Positive Emotion -> Intent to "Like" Post -> Vaccination Intention		**0.0083**	**0.0055**	**0.0003**	**0.0215**
Model 2: Through cognitive engagement, affective engagement, and intention to "share" post					

Indirect Effects		Effect	Bootstrap SE	Bootstrap LLCI	Bootstrap ULCI
GainLoss Framing -> Cognitive Engagement -> Vaccination Intention		-0.0137	0.028	-0.0707	0.0413
GainLoss Framing -> Positive Emotion -> Vaccination Intention		**0.0371**	**0.0208**	**0.0017**	**0.0829**
GainLoss Framing -> Intent to "Share" Post -> Vaccination Intention		-0.0136	0.0126	-0.0442	0.0049
GainLoss Framing -> Cognitive Engagement -> Intent to "Share" Post -> Vaccination Intention		-0.0004	0.001	-0.0027	0.0015
GainLoss Framing -> Positive Emotion -> Intent to "Share" Post -> Vaccination Intention		0.0056	0.0053	-0.0023	0.0186
Model 3: Through cognitive engagement, affective engagement, and intention to "comment on" post					

Indirect Effects		Effect	Bootstrap SE	Bootstrap LLCI	Bootstrap ULCI
GainLoss Framing -> Cognitive Engagement -> Vaccination Intention		-0.0138	0.0283	-0.0712	0.0418
GainLoss Framing -> Positive Emotion -> Vaccination Intention		**0.0354**	**0.0200**	**0.0015**	**0.0794**
GainLoss Framing -> Intent to "Comment on" Post -> Vaccination Intention		-0.0164	0.0144	-0.0509	0.0030
GainLoss Framing -> Cognitive Engagement -> Intent to "Comment on" Post -> Vaccination Intention		-0.0002	0.0007	-0.0018	0.0011
GainLoss Framing -> Positive Emotion -> Intent to "Comment on" Post -> Vaccination Intention		0.0073	0.0065	-0.0016	0.0232

Note: The referent condition is loss framing. Bolded indicates statistical significance at $p < .05$. LLCI = Lower limit Confidence Interval; ULCI = Upper Limit Confidence Interval. These analyses report the effect of the paths from the first-named variable to the last-named variable through the mediator, adjusting for baseline vaccination intention, vaccine hesitancy, and previous sexual experience. The bootstrap procedure (with 10,000 bootstrap samples) was used to compute the indirect effect and associated 95% confidence interval.
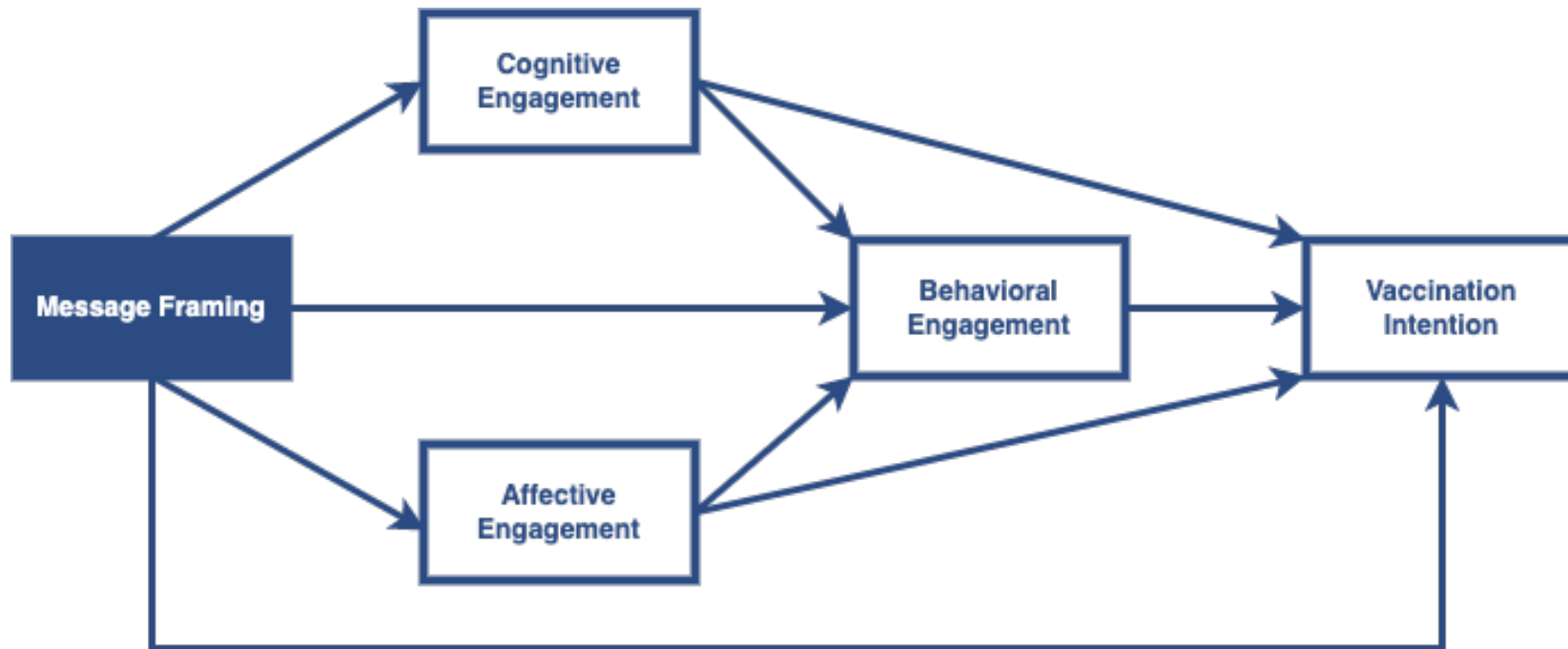
Figure 5.1: Hypothesized Mediation Model of The Current Study
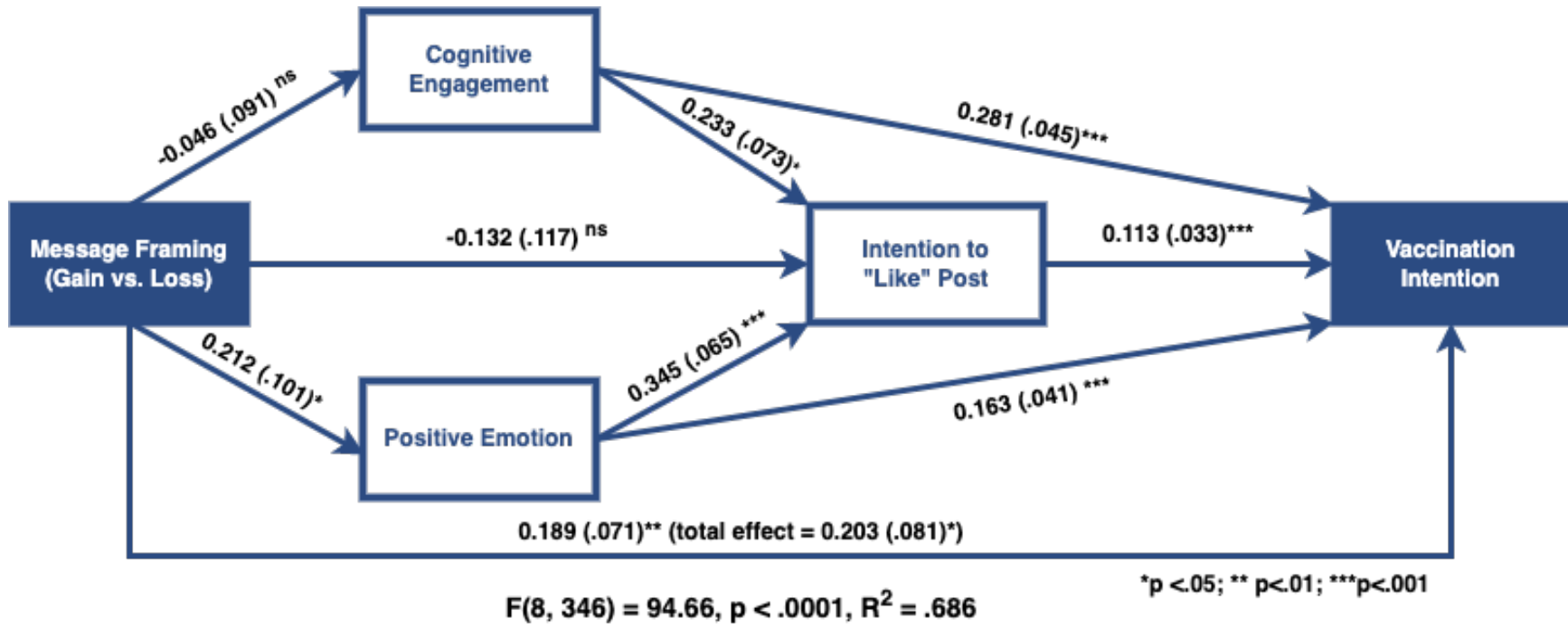
Figure 5.2: Direct Effects of Mediation Analyses (n=355) -- Model 1: Intention to "like" post
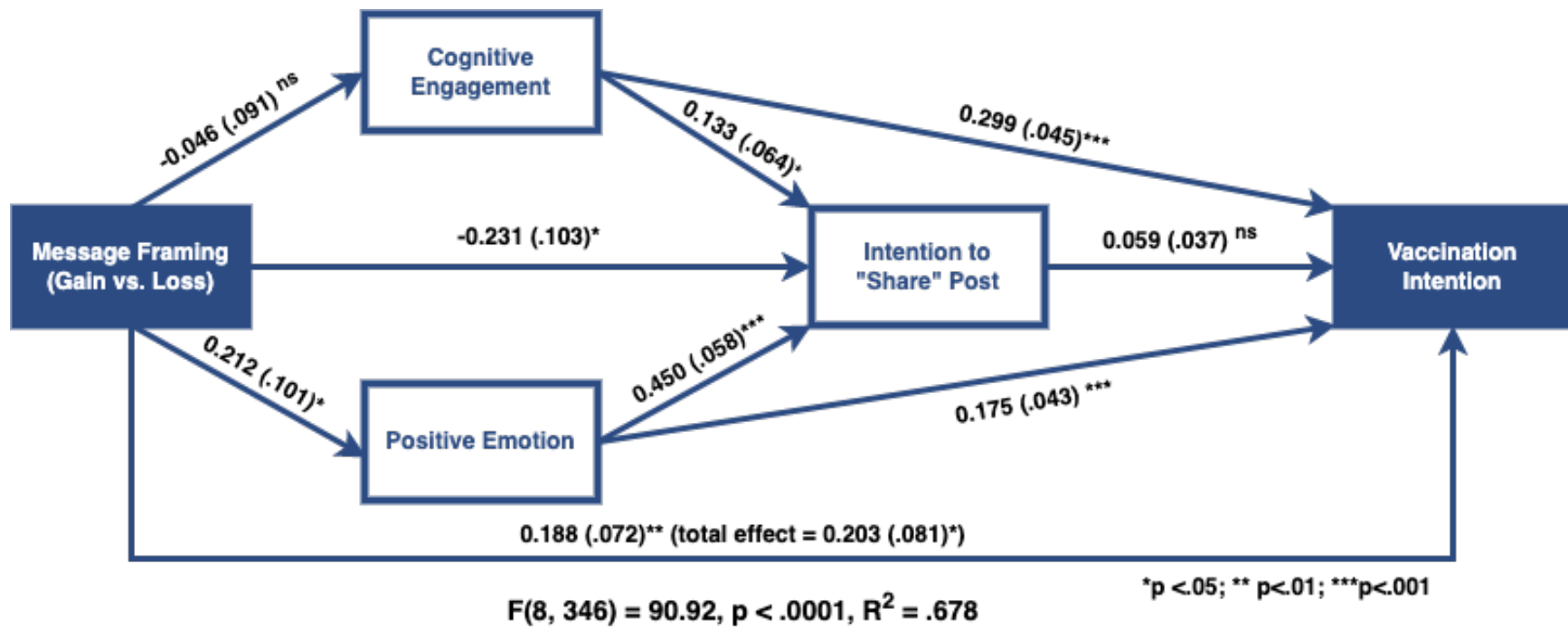
Figure 5.2 (Cont.): Direct Effects of Mediation Analyses (n=355) -- Model 2: Intention to share" post
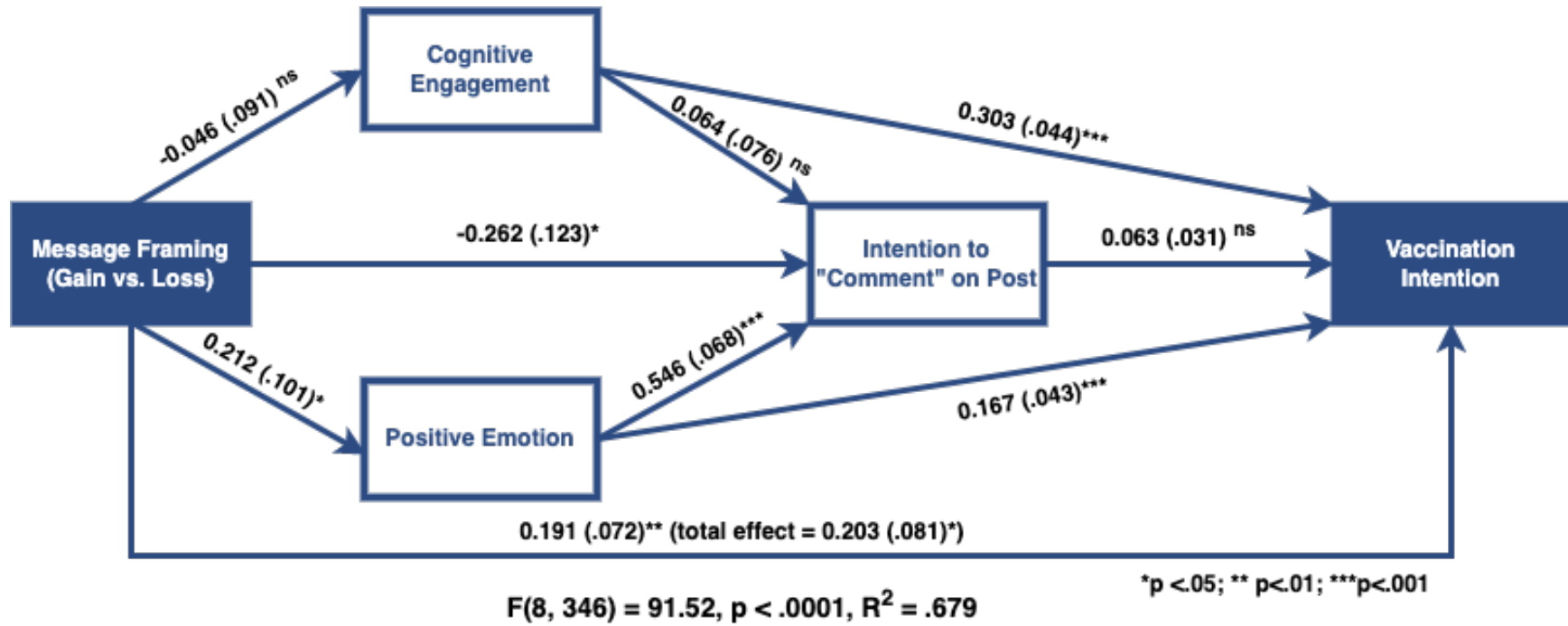
Figure 5.2 (Cont.): Direct Effects of Mediation Analyses (n=355) -- Model 3: Intention to "comment on" post

Chapter 6:

Study 3 - Do Social Endorsement Cues Affect Message Engagement & Credibility Perception on Instagram When Delivering Health Information?

Abstract

Purpose: Social endorsement cues, or system-aggregated information about user behavior or peer endorsement displayed on social network site (e.g., the number of likes on a Facebook post) have implications for credibility perception of health information. The current study aims to examine how intensity of social endorsement (high # of likes vs low) influence the credibility perceptions and engagement with the Instagram post related to HPV vaccination. **Methods:** College students (N=365) ages 18-26 that had not started the HPV vaccination series were recruited through Qualtrics to participate in an online randomized experiment. Participants either viewed an Instagram post with high (~500 likes) or low (~2 likes) endorsement. Multivariable regressions were conducted to examine the effect of social endorsement cues on credibility perception. **Results:** No differences in credibility perception were observed between low social endorsement condition (M=3.89, SD=0.05) and high social endorsement condition (M=3.88, SD=0.05, p=.978) after stimuli exposure. For engagement, being exposed to high social endorsement condition predicted significantly higher intention to like the post (M=3.70 vs 3.47, p=.03) and higher intention to share the post (M=3.02 vs 2.74, p<.01). **Conclusion:** Although social endorsement cues did not influence credibility perception in the current study, it has implications for reach of information in the context of a health communication information. It is critical to continue to understand the context and conditions under which audience may be influenced by different heuristic cues on SNS and optimize credibility perceptions of accurate health information.

Introduction

Digital sources not only permeate the information-seeking environment of the younger generation but can also have a profound influence in shaping their beliefs and behaviors (Fergie et al., 2016). Over 80% of emerging adults (18-29 years old) ever used any social networking sites (SNS) in 2021 (Auxier & Anderson, 2021). Public health practitioners and researchers have recognized the growing preference among young adults for gathering health information online, responding with increased efforts to promote positive health behavior change via SNS.

On the other hand, SNS use and exposures have been linked with negative health outcomes. Since the advent of the Internet, the proliferation and unregulated flow of information from various sources have raised concerns regarding the quality and credibility of information online (Cline & Haynes, 2001). This is further complicated by the introduction of SNS. SNS have greatly facilitated the collection and display of information about user perceptions. These aggregated data depicted on digital media, such as the number of "likes" or number of "shares" on a post, can serve as social endorsement cues that could potentially influence individual perceptions of the content. In literature, social endorsement cues have also been referred to as bandwagon cues, aggregate user representations, or virality metrics (J. W. Kim, 2018).

In the context of health communication campaigns on SNS, metrics that display audience engagement, such as likes, can potentially influence users' perceptions and credibility judgment of the message and the message source, which can in turn influence their message acceptance. Considering public health practitioners' and organizations' use of SNS to disseminate health information, understanding the dynamic features of SNS on credibility perceptions of health information is fundamental. A robust body of literature on health message framing demonstrates the influence of messages on an array of issues, including vaccination. However, few studies

have examined how health message framing affects individuals' perception of health information credibility on SNS, where endorsement cues are abundant. To address this research gap, we investigate the influence of social endorsement cues on credibility perceptions and engagement of a framed Instagram post on Human Papillomavirus (HPV) vaccination in the current study.

Social Endorsement Cues

Social endorsement or bandwagon effect is a phenomenon in which people adopt certain attitudes and behaviors because they believe that others around them are doing the same (Howard, 2019). In the context of SNS, individuals may use aggregated metrics displayed alongside the posts to infer what others think about the content while forming beliefs about the messages. In particular, the aggregated data displayed on SNS may serve as a social proof (Cialdini & James, 2009), where individuals could hold the perception that "if others think something is good, then it must be good for me as well," which is a mental shortcut for information processing. Based on this understanding, individuals may prefer or adopt messages that have received more favorable reviews or greater popularity, resulting in social endorsement effect.

A robust body of research has examined how social endorsement cues may influence individual evaluations of messages in different contexts. Most recently, a meta-analysis of 41 studies on bandwagon effects found a small positive effect (d=0.12) of bandwagon cues on credibility perceptions (Wang et al., 2023). However, these effects were significantly more likely to be observed in content topics related to marketing (e.g., purchasing products) compared to health or news topics (Wang et al., 2023).

In the context of health communication, a small but growing number of studies have examined the impact of social endorsement cues in the context of SNS. For example, in an

experiment, Lin & Spencer (2018) showed that levels of endorsement cues on Twitter (Low: 40 retweets, Moderate: 400 and High: 4000) did not overall influence the trustworthiness of food safety information. In another study, Kanthawala & Peng (2021), in the context of an online health community, also didn't find "likes" to influence credibility perception of information. In a study by Li and Sundar (2021), they found that bandwagon cues (in terms of # of viewers and positive comments) could reduce psychological reactance and improve persuasion by eliciting bandwagon perceptions in the context of binge drinking videos. Given the inconclusive result in this area of inquiry, the current paper aims to answer the following research question:

Research Question 1: How does intensity of social endorsement (i.e., high vs low) influence the credibility perceptions as well as engagement of the Instagram post on HPV vaccination?

Methods

The current study was based on an online panel of college students (N=365) recruited through Qualtrics between November 2022 and March 2023. Participants had to be enrolled in a university within the US at the time of the survey, use Instagram daily, and be able to read and write in English. Additionally, they had to have not initiated the HPV vaccination and be between ages 18 to 26, the recommended age group for HPV catch-up vaccination. This study was approved as exempt by the University of Arkansas Institutional Review Board.

Procedure and Materials

This study utilized a two-factor (social endorsement: high/low; frame: gain/loss) between subjects design. Participants were invited to take part in a study that aimed to evaluate health messages adapted for Instagram. Before the experiment, they completed a pretest to establish

their baseline characteristics and demographics. Subsequently, they were randomly assigned to a condition, exposed to the stimuli, and instructed to complete the posttest.

Message stimuli used in the study can be found in Appendix 1. The stimulus message was presented using an Instagram carousel format, which allows for up to 10 images or videos per post. Study participants could interact with the carousel posts by swiping left or clicking on an arrow button. Social endorsement was manipulated in terms of the "likes" on the post in the study. The post had 2 likes in the low social endorsement condition, whereas the post had 566 likes in the high social endorsement condition. The likes were pilot tested on a small group of students before the experiment.

Measures

Participants answered survey questions at baseline and immediately after message stimuli exposure in the current study.

The key outcome of interest was *message credibility*. This was measured by asking participants to rate how 1) trustworthy and 2) believable they thought the Instagram post they read was on a 5-point bipolar scale (e.g., 1= extremely untrustworthy, 5= extremely trustworthy). The two items were averaged to create a composite message credibility score (Cronbach alpha= .84), where a higher score indicates a higher message credibility perception.

Cognitive engagement with the stimuli was assessed with four 5-point questions (1= not at all, 5 = very much) by asking how much did the HPV vaccine message make them: 1) think about arguments for getting vaccinated for HPV? 2) think rather than feel, 3) think about the consequences of vaccination that were mentioned in the message, and 4) think about how getting HPV vaccination might affect your life. The four questions were averaged and combined into a composite cognitive engagement measure (Cronbach alpha =.85).

Emotional engagement was measured by asking if the message stimuli made participants felt a particular discrete emotion on a 5-point scale (1=None of this feeling, 5=Great deal of this feeling). For positive emotion (i.e., happy, encouraged), the two items were averaged into one composite positive emotion score (Cronbach alpha = .71). Similarly, for negative emotions (i.e., regretful, sad, angry, irritated), the items were averaged into one composite negative emotion score (Cronbach alpha = .81).

Behavioral Engagement was measured by asking how likely the participants were to interact with the Instagram message stimuli in the following ways on a 5-point scale (1=very unlikely, 5= very likely): 1) "Like" the post, 2) "Read comments" of the post, 3) "Comment" on the post, 4) "Share" on Instagram story, 5) "Share" on Instagram story for close friends only, 6) "Share" privately through direct messages, and 7) "Share" through other channels (e.g., text messages, Facebook). Items 4-7 were averaged to create a composite measure for "share" (Cronbach alpha = .91)

In addition to behavioral engagement, we also measured hypothetical *peer influence on behavioral engagement* by asking if participants saw a close friend to have liked the post, would they 1) more likely, 2) as likely, or 3) less likely to engage with the post by liking, reading the comments, commenting, or sharing the post.

Social Endorsement Cue Manipulation Check was first assessed by asking the participants to recall "how many likes did the post receive" with four choices: 0-10 likes, 11-100 likes, 101-500 likes and 500+ likes. Participants were then asked about their perception of the endorsement cue with the following items on a 7-point scale (1= strongly disagree, 7= strongly agree): 1) The HPV vaccination message from student health center had obtained a high number

of "likes" and 2) A large number of student Instagram users support the student health center's view on HPV vaccination.

Statistical Analysis

All analyses were conducted utilizing SAS 9.4 (Cary, NC). Chi-square and t-test were used to test difference in participant characteristics between groups at baseline and for manipulation check. Multivariable linear regression models were constructed to examine the effects of social endorsement cues on message credibility and engagement outcomes. Lastly, simple cross-tabulations were used to examine the patterns of engagement intent due to peer influence.

Results

Participant Characteristics

Participant (n=365) characteristics are summarized in Table 1. The average age of participants was 21.76 years (SD=2.30), and the majority of them were female (54%), non-Hispanic White (36%), in their first or second year of college (68%), and from the Southern region of the U.S. (46%). Most participants reported having engaged in sexual activity in the past (73%) and had an average score of 35.03 (SD=7.08) on the Adult Vaccine Hesitancy Scale (range 10-50).

Manipulation Check

Manipulation checks on social endorsement cues were successful. Participants were able to correctly recall the number of likes in the Instagram post χ^2 (3, n=365) = 148.77, p <.0001. Responses to the question "The HPV vaccination message from student health center had obtained a high number of likes" were significantly different between participants in the high social endorsement group (M=5.25, SD=1.41) and low social endorsement group (M=3.49, SD=1.98), t(363)= -9.80, p <.0001. The difference between high social endorsement group

(M=5.32, SD=1.09) and low social endorsement group (M=4.19, SD=1.59) on the question "a large number of student Instagram users support the student health center's view on HPV vaccination" was also statistically significant t(363) = -7.93, p <.0001.

Effects of Social Endorsement Cues

Linear regression models were constructed to examine the effect of social endorsement cues, controlling for message framing. An examination of the primary outcome, message credibility, showed that there were no differences between low social endorsement condition (M=3.89, SD=0.05) and high social endorsement condition (M=3.88, SD=0.05, p=.978). For engagement outcomes, being exposed to high social endorsement condition predicted significantly higher intention to like the post (M=3.70, SD=0.08) and higher intention to share the post (M=3.02, SD=0.07) compared to being exposed to low social endorsement condition (M_{like} = 3.47, SD = 0.08, p = .03; M_{share} = 2.74, SD = 0.07, p < .01). Other engagement outcomes, such as cognitive engagement, emotional engagement, and intention to comment on post also favored high social endorsement condition, but differences did not reach statistical significance.

Peer Influences on the Effect of Social Endorsement Cues

Table 3 summarize participant intention to engage with the Instagram post if they see a close friend who had "liked" the post. No differences were found between high and low social endorsement conditions, so only the overall results were reported. The majority of participants (47% -58%) indicated that seeing a close friend liked a post along with the like count did not influence their intention to engage (i.e., like, read comments, leave a comment, share) with the post. However, a sizable portion of participants indicated that they would be more likely to "read comments" associated with the post (44%), "like" the post (38%), "share" the post (28%), or "leave a comment" on the post (25%).

Discussion

The results of this study further the understanding the effect of social endorsement cues in the context of communicating HPV vaccination information on Instagram. Although participants noticed the number of likes on the post, we did not find evidence that social endorsement cues impact the credibility perception of the HPV Instagram post in the current study.

One possible explanation for this finding may be the source primacy effect, or the idea that when multiple heuristic cues are available, individuals tend to primarily employ source-related cues as a basis for credibility assessment (Sundar et al., 2007). According to source primacy effect, if a message is attributed to a source with high expertise, the presence of social endorsement cues would not significantly affect credibility evaluations. However, if a source is of low expertise, social endorsement cues could become increasingly salient and play a central role in shaping credibility perceptions. Given that student health centers are generally viewed favorably by college students as a health information source, the content may be subjected to source primacy effect.

This findings has implications for public health campaigns utilizing SNS. For campaigns that are building a social network site profile from scratch or not working with a known expert in a topic area, social endorsement of other users may play a bigger persuasive role. However, it should also be noted that a source expert may not be the same for everyone. For example, in the context of vaccination, vaccine hesitant individuals are more likely to distrust commonly cited public health experts such as the Centers for Disease Control (CDC), while at the same time trusting vaccine misinformation. Future research needs to further understand the nuance related

to social endorsement cues in driving credibility perception of message content on SNS when targeting populations that may be particularly vulnerable to health misinformation.

Despite the fact that social endorsement cues did not influence message credibility in the current study, we did find evidence that endorsement cues can influence the intention to engage with a post through liking and sharing it. This suggest that people may feel more comfortable engaging with online health information when they perceive that other users also agree with the post content. In the context of a health message intervention, this could have implications for message reach. A growing number of studies have examined features that are associated with more micro engagement on SNS. For example, Rus and Cameron (2016) found that inclusion of imagery, sentiment, presence of social support in the post, as well as use of links in the post could stimulate different forms of engagement. Health communication campaigns with goals to increase the reach of the content could incorporate these known features that may improve overall engagement, and subsequently enhance social endorsement cues for other audience. However, it remains a question whether there is an ideal dose of engagement, especially in the context of health communication, that practitioners should aim to achieve. For example, in Lin and Spence (2018), they found a food safety Twitter post with 400 retweets elicited the highest levels of trustworthiness compared to posts with 40 or 4,000 retweets, suggesting that variance in level of social endorsement could potentially moderate its effect on credibility perception. Future studies should further explore the context in which engagement on SNS will maximize communication persuasiveness.

We also found that a sizable portion of participants would be more likely to engage with the Instagram post when they see a close friend had previously engaged (i.e., liked) with the post; no differences were found between high social endorsement condition and low social

endorsement condition. This suggests that peer influence, despite being displayed as part of social endorsement cues on Instagram, may function as an independent factor that influences engagement on SNS. Normative influence of peers has been well documented in literature. In a health intervention, especially in the context of a closed network like the current study, it would be worth further exploring the role of peer influences on credibility perception and subsequent behavioral change when they appear as part of the heuristic cues on SNS.

Limitations

This study is subjected to a number of limitations. First, we only used number of likes as the indicator of social endorsement in the current study. In the context of Instagram, it is possible that comments associated with a post also serve as a social endorsement cue in information processing. Comments, unlike number of likes, may also point to participant sentiment toward the health message, and would be a fruitful future research area to better understand the effect of social endorsement cues on processing health messages in the digital space. Additionally, we measured participant micro-behaviors based on participants' intention to perform them and did not observe their behaviors in a natural setting. It would be critical to assess whether the same phenomenon is observed in an intervention study or other ecologically valid setting.

Conclusion

When using a student health center Instagram account to deliver HPV vaccination information, social endorsement does not appear to play a significant role in individual credibility perception of the health message. Despite that, we demonstrated that social endorsement cues predicted engagement (i.e., liking, and sharing) with the posts. Given the

increasing use of SNS for health information dissemination and interventions, it is critical to

continue to understand the context and conditions under which audience may be influenced by

different heuristic cues on SNS and optimize credibility perceptions of accurate health

information.

Tables and Figures

Table 6.1: Participant Characteristics (n=365)

Characteristics	Total (n=365)		Low Social Endorsement (n = 182)		High Social Endorsement (n = 183)	
	N	%	N	%	N	%
Demographic Variables						
Age, M(SD)	21.84	2.32	21.81	2.20	21.86	2.43
Sex						
Male	168	46%	87	48%	125	68%
Female	197	54%	95	52%	149	81%
Race & Ethnicity						
Non-Hispanics White	133	36%	69	38%	64	35%
Non-Hispanics Black or African American	81	22%	43	24%	38	21%
Non-Hispanics Other	40	11%	12	7%	28	15%
Hispanic, Latinx, or Spanish Origin	111	30%	58	32%	53	29%
Years in College						
1 year	115	32%	64	35%	51	28%
2 years	133	36%	63	35%	70	38%
3 years	63	17%	27	15%	36	20%
4 and more years	54	15%	28	15%	26	14%
Census Region Prior to College						
Northeast	72	20%	34	19%	38	21%
Midwest	62	17%	35	19%	27	15%
South	168	46%	79	43%	89	49%
West	59	16%	32	18%	27	15%
Variables Related to HPV Vaccine Information Processing						
Vaccine Hesitancy (Range 10 - 50)	35.03	7.08	34.68	7.09	35.37	7.06
Had ever engaged in any sexual activities	272	75%	139	76%	133	73%

Table 6.2: Outcomes by Social Endorsement Conditions

Outcomes (Ranges 1-5)	Low Social Endorsement		High Social Endorsement			95% Confidence Interval		
	M	**SD**	**M**	**SD**	**Beta**	**Lower Limit**	**Upper Limit**	**P-Value**
Message Credibility	3.89	0.05	3.88	0.05	0.002	-0.14	0.14	0.978
Engagement								
Cognitive engagement	3.47	0.06	3.57	0.06	0.09	-0.07	0.24	0.267
Positive emotion	2.81	0.07	2.94	0.07	0.13	-0.05	0.32	0.167
Negative emotion	1.86	0.05	1.90	0.05	0.05	-0.10	0.19	0.532
Intention to like	3.47	0.08	3.70	0.08	**0.23**	**0.02**	**0.44**	**0.034**
Intention to read comments	3.79	0.07	3.94	0.07	0.15	-0.04	0.34	0.125
Intention to comment	2.64	0.08	2.87	0.08	0.22	-0.01	0.45	0.067
Intention to Share	2.74	0.07	3.02	0.07	**0.28**	**0.07**	**0.48**	**0.008**

Note: analyses controlled for message framing

Table 6.3: Peer Influences on Likelihood to Engage with Instagram Post

Engagement Outcomes	Likelihood to Engage with the Post					
	Less likely		As likely		More likely	
	n	%	n	%	n	%
"Like" the post	37	10%	190	52%	138	38%
"Read Comments" about the post	30	8%	173	47%	162	44%
"Comments" on the post	61	17%	213	58%	91	25%
"Share" the post	55	15%	209	57%	101	28%

Note: Participants were asked to "imagine that they saw a close friend of theirs had liked the HPV vaccination post on Instagram

Chapter 7:

Discussion of Dissertation

Overview and Summary

Social network sites (SNS) have become part of the fabric of the modern society, with most individuals in the United States use some form of SNS and check their accounts at least daily (Smith & Anderson, 2018). In many ways, the ubiquitous use of SNS offers many opportunities for health communication and behavioral change. By meeting where people are, researchers and practitioners can tap into the functionalities of SNS (Kietzmann et al., 2011), allowing them to reach people with public health messages quickly, build online communities where people with similar health conditions can support each other, and provide people with increased access to programs and services. However, early systematic review and meta-analysis of SNS interventions only showed a slight net positive effect of SNS interventions on behavioral change (Laranjo et al., 2015), and high attrition of study participants and low engagement with interventions were reported (Maher et al., 2014). As such, researchers have called for more studies on the science of engagement in the context of SNS (S. Pagoto & Waring, 2016) to better harness these technologies for improving public health. In light of these gaps, the current dissertation set out to 1) examine the current state of measuring engagement within SNS-delivered health interventions, and 2) empirically examine the interplay between message framing, social endorsement and engagement in a randomized experiment using Instagram. Study findings illuminate the state of measuring engagement in SNS-delivered interventions, in addition to demonstrating the role of messaging framing and social endorsement cues in influencing engagement on SNS in a case study of HPV vaccination communication on Instagram.

The first manuscript, "Engagement Features and Measures in Health Behavior Interventions Utilizing Social Network Sites: A Scoping Review" is a review of literatures aimed at identifying and synthesizing how engagement is measured in existing SNS-delivered interventions that make use of a commercially available platform. This systematic scoping review revealed that there are growing number of studies utilizing commercially available SNS to deliver health interventions, targeting a wide variety of health topics. Many of the included studies utilize Facebook to deliver the health intervention, particularly through private Facebook group. A variety of study activities that make use of SNS, such as sharing content from both study staff and participants, moderated or non-moderated discussion, and live sessions were used in multiple studies. The study also suggests variations in how studies assessed engagement, with measures focused mostly on micro level engagement (e.g., viewing or liking a post). Future works should aim to incorporate different measures of engagement to improve future SNS-based interventions.

The second manuscript, "Engagement as A Mediator of The Effectiveness of Framed HPV Vaccination Promotion Messages On Instagram Among College Students: A Randomized Experiment", examined the role of message framing in influencing HPV vaccination intention as well as mediating role of micro and macro engagement in an experimental study. The study found that there is a relative advantage of gain-framed message over loss-framed message when communicating HPV vaccination information to a sample of college students on Instagram in promoting vaccination intention. However, neither group performed better than the knowledge-only control group. Mediation analysis revealed that the framing effect observed on vaccination intention was partially mediated through positive emotion experienced by participants. Cognitive engagement and SNS-based micro behaviors did not mediate the relationship. This study

provided feasibility of using Instagram to deliver a message framing intervention to communicate HPV vaccination information. This study also adds to the evidence base that micro engagement (e.g., liking a post) may provide limited information in understand the behavioral change pathway.

The third manuscript, "Do Social Endorsement Cues Affect Message Engagement & Credibility Perception on Instagram When Delivering Health Information?", examined the role of "likes" as a form of social endorsement cues in influencing engagement as well as credibility perception of HPV vaccination information using the same dataset as the second study. We tested if being exposed to high social endorsement (~500 likes), compared to low social endorsement (~2 likes), will lead to differences in participant credibility perception of the health information, as well as subsequent engagement behaviors with the posts. The study found that while study participant noticed the likes in the post and was able to recall the number of likes on the post, it did not lead to differences in credibility perception of the HPV information post. However, participants were more likely to have increased intention to "like" and "share" post if they were exposed to the high endorsement condition. The lack of differences in credibility perception between groups may be explained by source primacy effect, where social endorsement cues may only play a central role in information processing when the information source is not considered an expert.

Implications & Future Directions

Our studies revealed the complexity and challenges of using SNS to deliver health interventions. Although SNS has been around for over 15 years, and there is a vast amount of literature studying various aspect of it, our study revealed that it is not until in more recent time that public health researchers and practitioners are tapping into SNS more strategically for health

interventions, and people's engagement with those interventions. Based on findings from this dissertation, key opportunities are presented below:

Multi-methods approach to study engagement: Advancing the science of engagement within the context of SNS-delivered interventions should incorporate approaches to assessment of engagement that include both micro and macro level factors. For example, leveraging mixed methods, and integrating quantitative and qualitative data can dramatically expand the findings related to aspects of macro level engagement compared to either type of data separately might be able to tell. This approach may facilitate generating new hypothesis in behavioral change pathway in the digital age and improve tailoring of intervention messages that may be most effective.

Consistent reporting and effort to development engagement measures: The lack of consensus on what constitute engagement for SNS-delivered interventions and standardized measures that capture different types of engagement make it a difficult task to compare results across studies. However, the effort to develop engagement measures that can be used across studies may be difficult because each platforms have different functionalities and measures available. One viable pathway forward may be to think about functional building block of SNS (Kietzmann et al., 2011), and think about engagement in a modular way. For example, two key building blocks of SNS is conversation (i.e., the extent to which users communicate with each other) and group (i.e., the extent to which users form communities). A set of measures may be developed for each building block that allows researchers to apply a subset of all measure based on what engagement components they are employing in a given intervention study.

More nuanced understanding of social endorsement: Although social endorsement did not result in differential credibility perception of HPV vaccination information in the current

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study, the study was conducted in a very specific context, utilizing a college health center and only looking at number of likes. Additionally, social endorsement was predictive of behavioral engagement on Instagram. Given the abundance of health information, including misinformation, on SNS, a more nuanced understanding of social endorsement could help with intervention development. For example, several studies reviewed in this dissertation included study staff to monitor discussion within a SNS intervention to address questions and potential misinformation, it is not yet clear how exposure to these types of content may influence participant and if it requires special mitigation.

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Appendices

Appendix A. Search Terms for Scoping Review

#	PubMed Search Strings
1	Social media OR social networking site OR Facebook OR Twitter OR Instagram OR Snapchat OR YouTube OR TikTok OR Whatsapp OR Pinterest OR LinkedIn OR Reddit
2	"engage"[All Fields] OR "engaged"[All Fields] OR "engagement's"[All Fields] OR "engagements"[All Fields] OR "engages"[All Fields] OR "engaging"[All Fields] OR "social participation"[MeSH Terms] OR ("social"[All Fields] AND "participation"[All Fields]) OR "social participation"[All Fields] OR "engagement"[All Fields] OR immersion OR flow OR involvement OR presence OR adherence OR attrition
3	health OR behavior change OR health campaign OR communication campaign OR social marketing
4	"2004/1/1"[Date - Publication] : "2022/8/31"[Date - Publication])
5	English[Language]

Appendix B. Stimuli Material for Study 2 and 3

B.1 Control Condition

B.1 Control Condition Cont

4

3. HOW CAN I PREVENT HPV?

A: HPV vaccine **is available** and **recommended through age 26.** This vaccine has been approved by the FDA and CDC as **safe and effective.**

5

Framing material goes here

6

MAKE AN **APPOINTMENT** TODAY
(LINK IN BIO)

and talk with a physician at Student Health Center about getting the HPV vaccine

129

B.2 Gain Frame Condition
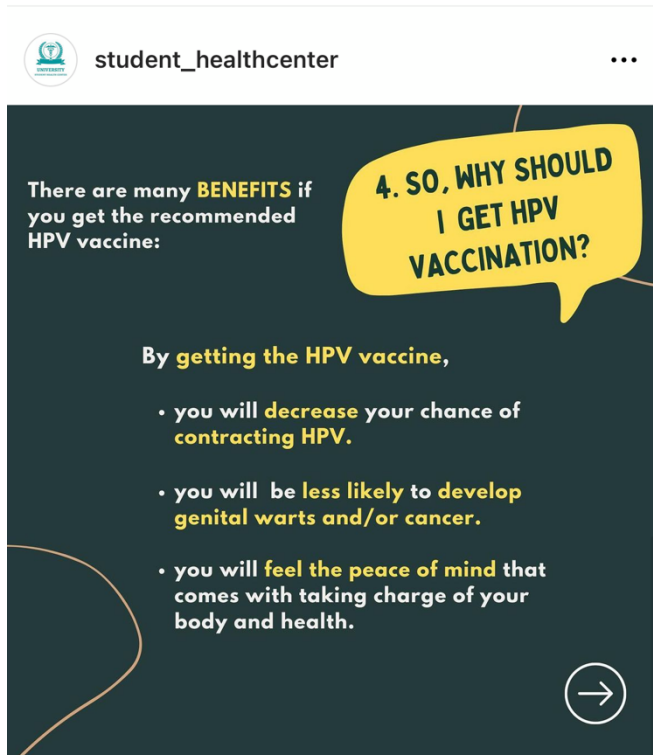
student_healthcenter · · ·

There are many **BENEFITS** if you get the recommended HPV vaccine:

4. SO, WHY SHOULD I GET HPV VACCINATION?

By **getting the HPV vaccine,**

• you will **decrease** your chance of **contracting HPV.**

• you will **be less likely** to **develop genital warts and/or cancer.**

• you will **feel the peace of mind** that comes with taking charge of your body and health.
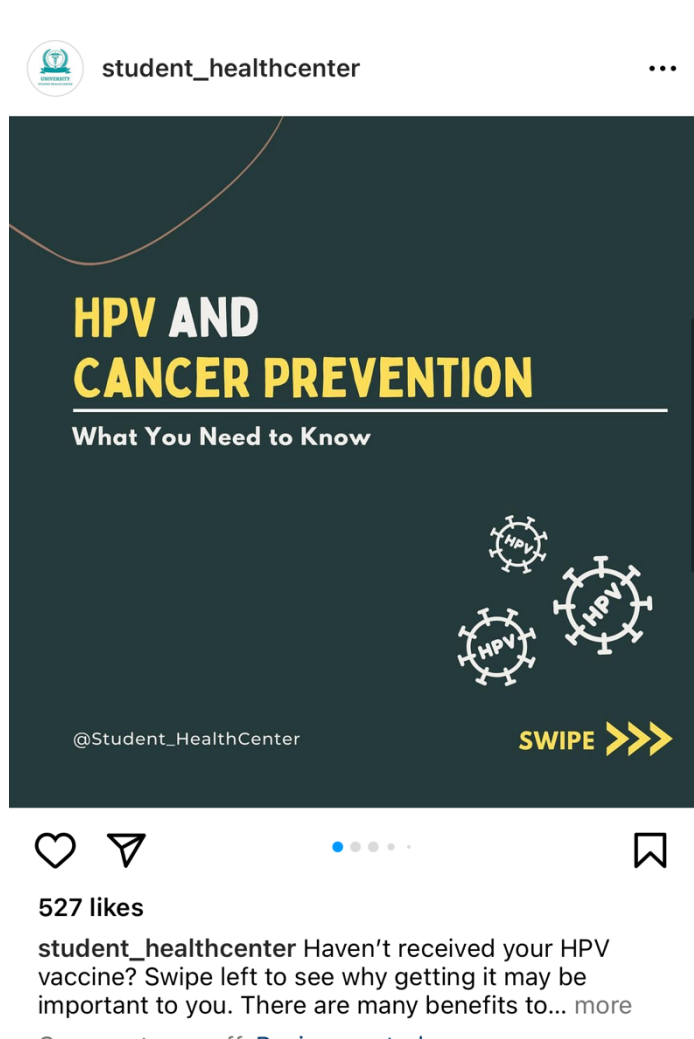
2 likes

student_healthcenter Haven't received your HPV vaccine? Swipe left to see why getting it may be important to you. There are many benefits to getting the HPV vaccine in college, including preventing 6 types of cancers affecting both men and women. Make an appointment (link in bio) at the student health center to get it today.

B.3 Loss Frame Condition

B.4 Social Endorsement Conditions – High

student_healthcenter

527 likes

student_healthcenter Haven't received your HPV vaccine? Swipe left to see why getting it may be important to you. There are many benefits to... more

B.5 Social Endorsement Conditions – Low

student_healthcenter ···

HPV AND CANCER PREVENTION

What You Need to Know

@Student_HealthCenter

View insights   **Boost post**

○ ○ ○ ○ ○

2 likes

student_healthcenter Haven't received your HPV shots? Make an appointment to talk to a physician at the student health center today about getting the HPV vaccine.

Appendix C: Study Informed Consent

Welcome to the Health Message Study! The purpose of the research study is to evaluate the health-related content of a social media post. Your participation is voluntary.

 What are the risks?
 While risks are minimal, you may experience discomfort in answering some of the survey questions and you may stop your participation in this study at any time. Since this survey is anonymous, no one will know your answers. Factual information related to the health messages you read will be available at the end of the study.

 How will I benefit from the study?
 There are no direct benefits to you aside from the compensation as agreed to while entering the survey. The benefits to science and humankind that might result from this study are a better understanding health message design on social media.

 Who is doing this research study?
 Shawn Chiang, a PhD candidate in Health Behavior and Health Promotion at University of Arkansas (phone 479-575-3845 or email schiang@uark.edu) is leading this study, and is supervised by Dr. Philip Massey, Associate Professor (phone 479-575-8491).

 What will I be doing if I am in the research study?
 You will complete an online survey that will take about 15 minutes. You will first answer questions in the online survey about yourself (like your age), and social media use. Next, we may ask you to view one health message in the form of a social media post and finally we will ask a few more questions when you are finished viewing the post.

 What are my rights? Your participation in this study is voluntary. You do not have to be in the study. If you have questions or concerns about your rights as a research participant, please contact Ro Windwalker, at the Office of Research Integrity & Compliance at (479) 575-2208 or email irb@uark.edu.
 What information will be kept private?
 Only the study team will see the survey data, unless university or government officials ask to inspect our records. When we talk about what we find in this study, we will not use any information that could identify who you are.

 Documentation of Consent
 Now that you have read the information about the study, please read and answer each of the following statements.

I have read, or been informed of, the information about this study.

    ○ Yes (1)

    ○ No (0)

I hereby consent to participate in the study.

    ○ Yes (1)

    ○ No (0)

Appendix D: Study Survey Instrument for Study 2 and 3 (Chapter 5 and 6)

What is your current age?

○ 14 (14)

○ 15 (15)

○ 16 (16)

○ 17 (17)

○ 18 (18)

○ 19 (19)

○ 20 (20)

○ 21 (21)

○ 22 (22)

○ 23 (23)

○ 24 (24)

○ 25 (25)

○ 26 (26)

○ 27 (27)

○ 28 (28)

○ 29 (29)

○ 30 (30)

○ 31 (31)

○ 32 (32)

○ 33 (33)

○ 34 (34)

○ 35 (35)

○ > 35 (36)

What is the highest degree or level of school you have completed?

○ Did not complete high school (1)

○ GED or alternative credential (2)

○ High school diploma (3)

○ Some college - 1 year (4)

○ Some college - 2 years (5)

○ Some college - 3 years (6)

○ Some college - 4 years (7)

○ Some college - 4+ years (8)

○ Associate's or Bachelor's degree (9)

○ Masters degree, professional degree or doctoral degree (10)

End of Block: Eligibility - Age and Education

Start of Block: Social Media

What university or college do you currently attend?

_____

Now, we would like to ask you some questions about your social media use.

- -

Which of the following social media platforms do you use currently? (Choose all that apply)

☐   Twitter (1)

☐   Instagram (2)

☐   Facebook (3)

☐   Snapchat (4)

☐   YouTube (5)

☐   TikTok (6)

☐   WhatsApp (7)

☐   Pinterest (8)

☐   Discord (9)

☐   Reddit (10)

☐   BeReal (11)

☐   Twitch (12)

- -

Thinking about the social media sites you use, about how often do you visit or use them?

	Several times a day (1)	About once a day (2)	A few times a week (3)	Once a week (4)	Less than once a week (5)
Twitter (1)	○	○	○	○	○
Instagram (6)	○	○	○	○	○
Facebook (7)	○	○	○	○	○
Snapchat (8)	○	○	○	○	○
YouTube (9)	○	○	○	○	○
TikTok (10)	○	○	○	○	○
WhatsApp (11)	○	○	○	○	○
Pinterest (12)	○	○	○	○	○
Discord (13)	○	○	○	○	○
Reddit (14)	○	○	○	○	○
BeReal (5)	○	○	○	○	○
Twitch (3)	○	○	○	○	○

End of Block: Social Media

Start of Block: HPV Vaccination History

Now, we would like to ask you some questions about your health beliefs and behaviors.

- -

Have you ever heard of human papillomavirus or HPV?

○ Yes (1)

○ No (0)

○ Not sure (9)

- -

Have you ever heard of the HPV vaccine or the HPV shot (also known as Gardasil)?

○ Yes (1)

○ No (0)

○ Not sure (9)

- -

Have you initiated or received the HPV vaccine?

○ Yes (1)

○ No (0)

○ Not sure (9)

End of Block: HPV Vaccination History

Start of Block: HPV Vaccination Delay

Which of the following are reasons why you have not initiated the HPV vaccine series? (Choose all that apply)

☐   Concern about side effects (1)

☐   Vaccines is too new and not tested enough (2)

☐   Doctor didn't recommend I get the HPV vaccine (3)

☐   Doctor didn't offer vaccine (4)

☐   Concern about effectiveness of the vaccine (5)

☐   Don't have sex, don't need the HPV vaccine (6)

☐   Don't like shots/needles (7)

☐   Already diagnosed with HPV (8)

☐   Don't trust vaccine (9)

☐   Don't have access to doctor that offers vaccines (10)

☐   Don't know about the HPV vaccine (11)

☐   Too inconvenient to get vaccine series (12)

☐   Parents wouldn't let me get the vaccine (13)

☐   Don't have health insurance (14)

☐   Other (please describe below) (15)

_____

We would like to know your general views about vaccines. Please tell us how much you agree or disagree with the following statements.

	Strongly disagree (1)	Somewhat disagree (2)	Neither agree nor disagree (3)	Somewhat agree (4)	Strongly agree (5)
Vaccines are important for my health. (1)	○	○	○	○	○
Vaccines are effective. (2)	○	○	○	○	○
Being vaccinated is important for the health of others in my community. (4)	○	○	○	○	○
All routine vaccinations recommended by the CDC are beneficial. (5)	○	○	○	○	○
New vaccines carry more risks than older vaccines. (6)	○	○	○	○	○
The information I receive about vaccines from the CDC is reliable and trustworthy. (7)	○	○	○	○	○

Getting vaccines is a good way to protect me from disease. (8)	○	○	○	○	○
Generally, I do what my doctor or healthcare provider recommends about vaccines for me. (9)	○	○	○	○	○
I am concerned about serious adverse effects of vaccines. (10)	○	○	○	○	○
I do not need vaccines for diseases that are not common anymore. (11)	○	○	○	○	○

Please answer how much you agree or disagree with the following statements:

I plan to initiate the HPV vaccination series in the next 6 months.

○ Strongly agree (5)

○ Agree (4)

○ Neither agree nor disagree (3)

○ Disagree (2)

○ Strongly disagree (1)

I plan to make an appointment to get the HPV Vaccine in the next 6 months.

○ Strongly agree (5)

○ Agree (4)

○ Neither agree nor disagree (3)

○ Disagree (2)

○ Strongly disagree (1)

Page Break

I plan to talk about the HPV vaccine with someone close to me.

○ Strongly agree (5)

○ Agree (4)

○ Neither agree nor disagree (3)

○ Disagree (2)

○ Strongly disagree (1)

I plan to ask a healthcare provider about the HPV vaccine.

○ Strongly agree (5)

○ Agree (4)

○ Neither agree nor disagree (3)

○ Disagree (2)

○ Strongly disagree (1)

I plan to look for more information about HPV vaccine.

○ Strongly agree (5)

○ Agree (4)

○ Neither agree nor disagree (3)

○ Disagree (2)

○ Strongly disagree (1)

I am confident that if I really wanted to, I could get the HPV vaccine in the next 6 months.

○ Strongly agree (5)

○ Agree (4)

○ Neither agree nor disagree (3)

○ Disagree (2)

○ Strongly disagree (1)

Getting the HPV vaccine in the next 6 months is completely up to me.

○ Strongly agree (5)

○ Agree (4)

○ Neither agree nor disagree (3)

○ Disagree (2)

○ Strongly disagree (1)

Please rate each of the following statements.

I think the chances for me to suffer from side effects after receiving the HPV vaccine are

○ Very High (5)

○ Somewhat high (4)

○ Neither low nor high (3)

○ Somewhat low (2)

○ Very low (1)

- -

The side effects of getting vaccination are typically severe for me.

○ Strongly agree (5)

○ Somewhat agree (4)

○ Neither agree nor disagree (3)

○ Somewhat disagree (2)

○ Strongly disagree (1)

- -

Page Break

Picturing myself getting infected with HPV is something I find:

○ Very hard to do (1)

○ Somewhat hard to do (2)

○ Neither hard or easy to do (3)

○ Somewhat easy to do (4)

○ Very easy to do (5)

Picturing myself getting HPV-related cancers is something I find:

○ Very hard to do (1)

○ Somewhat hard to do (2)

○ Neither hard or easy to do (3)

○ Somewhat easy to do (4)

○ Very easy to do (5)

End of Block: Perceived Risk - Pre Test

Start of Block: Stimulus Exposure Intro

--Study Instructions --
 Please Read Carefully   On the next page, you will be shown a brief health message in the form of an **Instagram** post.

 Please imagine this post is from **${College/ChoiceTextEntryValue}** **student health center.**

 This student health center is active on Instagram and **gets around 80-100 likes typically per post.**

 When you go to the next page, please **CLICK** on the post. **A pop-up will show up.**

There are multiple pages to this post -- you can swipe or use the right and left arrows to navigate the content. When you are done, you can exit out of the post and go to the next page.

Please read the post carefully. We will be asking you some questions about the message that you read. ---

Stimulus material is shown here.

Thank you for taking the time to read the Instagram post.

Next, we are going to ask you some questions about the content you read.

Please answer how much you agree or disagree with the following statements.

The HPV vaccination message I read highlighted the good things that could happen if I get vaccinated for HPV.

○ Strongly agree (7)

○ Agree (6)

○ Somewhat agree (5)

○ Neither agree nor disagree (4)

○ Somewhat disagree (3)

○ Disagree (2)

○ Strongly disagree (1)

The HPV vaccination message I read highlighted the bad things that could happen if I don't get vaccinated for HPV.

○ Strongly agree (7)

○ Agree (6)

○ Somewhat agree (5)

○ Neither agree nor disagree (4)

○ Somewhat disagree (3)

○ Disagree (2)

○ Strongly disagree (1)

The HPV vaccination message I read had.......

○ 0 - 10 likes (1)

○ 11 - 100 likes (2)

○ 101 - 500 likes (3)

○ 500+ likes (4)

Page Break

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The HPV vaccination message from student health center had obtained a high number of "likes".

○ Strongly agree (7)

○ Agree (6)

○ Somewhat agree (5)

○ Neither agree nor disagree (4)

○ Somewhat disagree (3)

○ Disagree (2)

○ Strongly disagree (1)

- -

A large number of student Instagram users support the student health center's view on HPV vaccination.

○ Strongly agree (7)

○ Agree (6)

○ Somewhat agree (5)

○ Neither agree nor disagree (4)

○ Somewhat disagree (3)

○ Disagree (2)

○ Strongly disagree (1)

End of Block: Manipulation Check

Start of Block: Defensive Processing

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Think back to the HPV vaccination message you just read. Please list up to 3 thoughts you had, if any, while you were reading it.

Please write only one thought in each box. If none, please put NA.

○ 1) (1) _____

○ 2) (2) _____

○ 3) (3) _____

Please answer how much you agree or disagree with the following statements:

- -

I plan to initiate the HPV vaccination series in the next 6 months.

○ Strongly agree (5)

○ Agree (4)

○ Neither agree nor disagree (3)

○ Disagree (2)

○ Strongly disagree (1)

- -

I plan to make an appointment to get the HPV Vaccine in the next 6 months.

○ Strongly agree (5)

○ Agree (4)

○ Neither agree nor disagree (3)

○ Disagree (2)

○ Strongly disagree (1)

Page Break

I plan to talk about the HPV vaccine with someone close to me.

○ Strongly agree (5)

○ Agree (4)

○ Neither agree nor disagree (3)

○ Disagree (2)

○ Strongly disagree (1)

I plan to ask a healthcare provider about the HPV vaccine.

○ Strongly agree (5)

○ Agree (4)

○ Neither agree nor disagree (3)

○ Disagree (2)

○ Strongly disagree (1)

I plan to look for more information about HPV vaccine.

○ Strongly agree (5)

○ Agree (4)

○ Neither agree nor disagree (3)

○ Disagree (2)

○ Strongly disagree (1)

Based on the text below, what would you say your favorite fitness activity is?

 This is a simple question. You don't need to be a fitness enthusiast in order to answer. When asked for your favorite fitness activity, you need to select yoga.

○ Running (1)

○ Hiking (2)

○ Group fitness classes (3)

○ Yoga (4)

○ Swimming (5)

○ Tennis (6)

○ None of the above (7)

Recalling the HPV vaccination post you have just read, how likely are you to interact with the post in the following ways?

	Very unlikely (1)	Somewhat unlikely (2)	Neither (3)	Somewhat likely (4)	Very likely (5)
"Like" the post (1)	○	○	○	○	○
"Read" comments about this post (8)	○	○	○	○	○
"Share" on Instagram story (3)	○	○	○	○	○
"Share" on Instagram story for close friends only (4)	○	○	○	○	○
"Share" privately through Instagram DM (Direct Message) (6)	○	○	○	○	○
"Share" through other channels (e.g., text messages, Facebook) (9)	○	○	○	○	○
"Comment" on the post (2)	○	○	○	○	○

Page Break

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Now, imagine that you saw a close friend of yours had liked the HPV vaccination post on Instagram.

As a result of that, how more or less likely would you be to interact with the post in the following ways?

	Less likely (1)	Same (2)	More likely (3)
"Like" the post (1)	○	○	○
"Read" comments about this post (8)	○	○	○
"Share" the post (3)	○	○	○
"Comment" on the post (2)	○	○	○

End of Block: Message Engagement

Start of Block: Cognitive Engagement

Overall, how much did the HPV vaccination post make you:

- -

...think about reasons for getting vaccinated for HPV?

○ Very much (5)

○ More than somewhat (4)

○ Somewhat (3)

○ Not very much (2)

○ Not at all (1)

- -

...“think” rather than “feel”?

- ○ Very much (5)

- ○ More than somewhat (4)

- ○ Somewhat (3)

- ○ Not very much (2)

- ○ Not at all (1)

...think about the consequences of vaccination that were mentioned in the message?

- ○ Very much (5)

- ○ More than somewhat (4)

- ○ Somewhat (3)

- ○ Not very much (2)

- ○ Not at all (1)

...think about how getting the HPV vaccination might affect your life?

- ○ Very much (5)

- ○ More than somewhat (4)

- ○ Somewhat (3)

- ○ Not very much (2)

- ○ Not at all (1)

In general, my reactions to the HPV vaccination message were:

○ Very Positive (7)

○ Somewhat positive (6)

○ A little positive (5)

○ Neither negative or positive (4)

○ A little negative (3)

○ Somewhat negative (2)

○ Very Negative (1)

End of Block: Cognitive Engagement

Start of Block: Affective Engagement

We are interested in how the message you read made you "feel". Please Indicate how much the HPV post made you feel the following ways:

	1 None of this feeling (1)	**2** Not very much of this feeling (2)	**3** Some of this feeling (3)	**4** More than somewhat of this feeling (4)	**5** Great deal of this feeling (5)
Regretful (1)	○	○	○	○	○
Sad (3)	○	○	○	○	○
Angry (12)	○	○	○	○	○
Irritated (13)	○	○	○	○	○
Encouraged (6)	○	○	○	○	○
Happy (8)	○	○	○	○	○

While reading the messages, were you......

	Not at all (1)	Not very much (2)	Somewhat (3)	More than somewhat (4)	Very much (5)
Criticizing the messages? (1)	○	○	○	○	○
Think of points that went against the arguments presented? (2)	○	○	○	○	○
Feeling skeptical of the arguments presented? (3)	○	○	○	○	○

How **trustworthy** do you think the HPV vaccination post was?

○ Extremely trustworthy (5)

○ Somewhat trustworthy (4)

○ Neither trustworthy nor untrustworthy (3)

○ Somewhat untrustworthy (2)

○ Extremely untrustworthy (1)

How **believable** do you think the HPV vaccination post was?

○ Extremely believable (5)

○ Somewhat believable (4)

○ Neither believable nor unbelievable (3)

○ Somewhat unbelievable (2)

○ Extremely unbelievable (1)

I am confident that if I really wanted to, I could get the HPV vaccine in the next 6 months.

○ Strongly agree (5)

○ Agree (4)

○ Neither agree nor disagree (3)

○ Disagree (2)

○ Strongly disagree (1)

Getting the HPV vaccine in the next 6 months is completely up to me.

○ Strongly agree (5)

○ Agree (4)

○ Neither agree nor disagree (3)

○ Disagree (2)

○ Strongly disagree (1)

Please rate each of the following statements.

I think the chances for me to suffer from side effects after receiving the HPV vaccine are

○ Very High (5)

○ Somewhat high (4)

○ Neither low nor high (3)

○ Somewhat low (2)

○ Very low (1)

The side effects of getting vaccination are typically severe.

○ Strongly agree (5)

○ Somewhat agree (4)

○ Neither agree nor disagree (3)

○ Somewhat disagree (2)

○ Strongly disagree (1)

- -

Page Break ───────────────────────────────────

Picturing myself getting infected with HPV is something I find:

○ Very hard to do (1)

○ Somewhat hard to do (2)

○ Neither hard or easy to do (3)

○ Somewhat easy to do (4)

○ Very easy to do (5)

Picturing myself getting HPV-related cancers is something I find:

○ Very hard to do (1)

○ Somewhat hard to do (2)

○ Neither hard or easy to do (3)

○ Somewhat easy to do (4)

○ Very easy to do (5)

How difficult or easy was it for you **to read** the HPV vaccination message?

○ Extremely Easy (5)

○ Somewhat easy (4)

○ Neither easy nor difficult (3)

○ Somewhat difficult (2)

○ Extremely difficult (1)

How difficult or easy was it for you **to understand** the HPV vaccination message?

○ Extremely Easy (5)

○ Somewhat easy (4)

○ Neither easy nor difficult (3)

○ Somewhat difficult (2)

○ Extremely difficult (1)

How often do you need help to read instructions, pamphlets, or other written material from your doctor or pharmacy?

○ Always (5)

○ Often (4)

○ Sometimes (3)

○ Rarely (2)

○ Never (1)

Next, we are going to ask you about sexual activities that some people do. Please answer honestly and keep in mind that your answers are anonymous.

Have you ever had any kind of sex (e.g., oral, vaginal, anal) with any sexual partner?

○ Yes (1)

○ No (0)

Would you follow your university's student health center on social media to receive health information relevant to college students?

○ Yes (1)

○ No (0)

Thinking about Instagram specifically, which of the following features should university's student health center use to share health information with you? (Choose all that apply)

☐　　　　Posts - single image or multiple images (1)

☐　　　　Instagram Stories (i.e., posts that disappear after 24 hours) (2)

☐　　　　Instagram Reels (i.e., 15 sec videos) (3)

☐　　　　Instagram Live (i.e., live stream) (4)

☐　　　　Direct Messages (5)

☐　　　　Other (6) _____

Lastly, we would like to wrap up this survey by asking a few questions about yourself.

- -

Prior to attending college, what was your 5-digit zip code?

_____

- -

Are you a person of Hispanic, Latino, or Spanish origin?

○ Yes (1)

○ No (0)

- -

What is your race? (Choose all that apply)

☐　　　American Indian or Alaska Native (1)

☐　　　Asian (2)

☐　　　Black or African American (3)

☐　　　Native Hawaiian or Other Pacific Islander (4)

☐　　　White (5)

☐　　　Other (6) _____

- -

Where were you born?

○ In the United States (1)

○ Outside of the United States (4)

- -

What sex were you assigned at birth on your original birth certificate?

○ Female (0)

○ Male (1)

- -

Do you currently describe yourself as male, female or transgender?

○ Female (1)

○ Male (2)

○ Transgender (3)

○ None of these (4)

- -

Which of the following best represents how you think of yourself?

○ Gay or lesbian (1)

○ Straight, that is not gay or lesbian (2)

○ Bisexual (3)

○ Something else (4)

○ I don't know (5)

End of Block: Demographics

Appendix E: IRB Approval Letter

UNIVERSITY OF ARKANSAS

To:	Shawn Chiang
From:	Douglas J Adams, Chair
	IRB Expedited Review
Date:	10/17/2022
Action:	**Exemption Granted**
Action Date:	10/17/2022
Protocol #:	2209423585
Study Title:	The interplay between message framing, social endorsement, and engagement on social media: an online panel experiment

The above-referenced protocol has been determined to be exempt.

If you wish to make any modifications in the approved protocol that may affect the level of risk to your participants, you must seek approval prior to implementing those changes. All modifications must provide sufficient detail to assess the impact of the change.

If you have any questions or need any assistance from the IRB, please contact the IRB Coordinator at 109 MLKG Building, 5-2208, or irb@uark.edu.

cc: Philip Massey, Investigator
      Alex Russell, Investigator