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Exposure to positive peer sentiment about nicotine replacement therapy in an online smoking cessation community is associated with NRT use

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HIGHLIGHTS

- Concerns about the safety and efficacy of NRT are common among treatment-seeking smokers.
- Positive peer sentiment about NRT in an online social network increases the likelihood of use when smokers have to acquire NRT on their own.
- When NRT is available for free, peer sentiment does not appear to influence NRT use.

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ABSTRACT

Background: Little is known about the influence of online peer interactions on health behavior change. This study examined the relationship between exposure to peer sentiment about nicotine replacement therapy (NRT) in an online social network for smoking cessation and NRT use.

Methods: Participants were 3297 current smokers who enrolled in an Internet smoking cessation program, participated in a randomized trial, and completed a 3-month follow-up. Half received free NRT as part of the trial. Automated text classification identified 27,038 posts about NRT that one or more participants were exposed to in the social network. Sentiment towards NRT was rated on Amazon Mechanical Turk. Participants' exposure to peer sentiment about NRT was determined by analysis of clickstream data. Modified Poisson regression examined self-reported use of NRT at 3-months as a function of exposure to NRT sentiment, controlling for study arm and post exposure.

Results: One in five participants (19.3%, $n = 639$) were exposed to any NRT-related posts (mean exposure = 6.5 ± 14.7, mean sentiment = 5.4 ± 0.8). The association between sentiment exposure and NRT use varied by receipt of free NRT. Greater exposure to positive NRT sentiment was associated with an increased likelihood of NRT use among participants who did not receive free NRT (adjusted rate ratio 1.22, 95% CI 1.01, 1.47; $p = .043$), whereas no such relationship was observed among participants who did receive free NRT ($p = .48$).

Conclusions: Exposure to positive sentiment about NRT was associated with increased NRT use when smokers obtained it on their own. Highlighting user-generated content containing positive NRT sentiment may increase NRT use among treatment-seeking smokers.

1. Introduction

With nearly universal Internet adoption (Pew Research Center, 2017) and the growing use of dedicated social networks for health (Centola, 2013), online social networks have become increasingly common sources of "peer-to-peer healthcare" (Fox, 2011). Through

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online social networks, people learn from the personal experiences of others with similar conditions (Graham, Cobb, & Cobb, 2016). Health information obtained through social networks can influence the decisions people make about coping with chronic conditions, such as decisions about taking medication (Cobb, Mays, & Graham, 2013; Health Research Institute, 2012).

Over twelve million smokers search online for information about quitting each year, (Graham & Amato, 2018) and hundreds of thousands participate in online social networks for cessation (McCausland et al., 2011; van Mierlo, Voci, Lee, Fournier, & Selby, 2012; Wangberg, Nilsen, Antypas, & Gram, 2011; Zhao et al., 2016). Advances in computing methods that allow coding of large volumes of user-generated content have enabled several studies of common topics of discussion in online networks for cessation (Brandt, Dalum, Skov-Ettrup, & Tolstrup, 2013; Burri, Baujard, & Etter, 2006; S Myneni, Cobb, & Cohen, 2016; S. Myneni, Cobb, & Cohen, 2013; Selby, van Mierlo, Voci, Parent, & Cunningham, 2010). Less is known about the sentiment expressed or its influence on cessation-related behavior. To date, most tobacco-related sentiment analysis studies have involved Twitter data, using tweets to describe sentiment towards conventional and emerging tobacco products (Cole-Lewis et al., 2015; Myslin, Zhu, Chapman, & Conway, 2013; Rose, Binns, Buenger, Emery, & Ribisl, 2017) and to survey smoking status and sentiment about smoking (Sofean & Smith, 2013). We are aware of only one sentiment analysis study in an online social network for cessation that examined exposure to sentiment about varenicline and subsequent change in cessation medication preferences (Cobb et al., 2013); however, this analysis did not include behavioral outcome data.

Building upon prior work, this study focuses on whether exposure to peer sentiment concerning nicotine replacement therapy (NRT) influences smokers' use of NRT. NRT can double the chance of successful cessation and is a central component of tobacco dependence treatment (Fiore, Jaén, Baker, & Tobacco Use and Dependence Guideline Panel, 2008; Stead et al., 2012; Zhang, Cohen, Bondy, & Selby, 2015). However, most smokers do not use NRT (Fu et al., 2008; Hung, Dunlop, Perez, & Cotter, 2011; Soulakova & Crockett, 2017, 2018) and many perceive it to be ineffective and as harmful as cigarettes (Shiffman, Ferguson, Rohay, & Gitchell, 2008). The pros and cons of NRT are often a contentious point of discussion among smokers. Scientific debate about the population-level effectiveness of NRT (Alpert, Connolly, & Biener, 2013; Smith & Chapman, 2014) and related media coverage (Carey, 2012; Kaplan, 2012) periodically fuel such discussions. This study leveraged a unique dataset that included NRT use from smokers participating in a randomized trial and a complete mapping of their exposure to user-generated content and sentiment about NRT in an online social network for smoking cessation. The primary aims of this research were to: 1) characterize the sentiment of user-generated content about NRT; 2) determine if there were differences by participant characteristics in the extent of NRT post exposure or mean sentiment of post exposure; and, 3) examine the relationship between exposure to NRT sentiment and actual NRT use. Previous findings from the parent study (Graham et al., 2017) demonstrated that provision of free NRT increased the use of NRT. As a secondary aim, we took advantage of the study design to examine whether provision of free NRT moderated the relationship between NRT sentiment exposure and actual NRT use.

2. Methods

2.1. Human subjects

Participants were current smokers enrolled in a randomized smoking cessation treatment trial conducted on BecomeAnEX, a free, publicly available Internet cessation program. The trial was conducted from March 2012–January 2015 (ClinicalTrials.govNCT01544153). All participants provided informed consent. The trial protocol was approved by Western Institutional Review Board (#20110877). These analyses link data on trial participants with the full longitudinal BecomeAnEX dataset that spans 2008–2015 conducted under a study protocol approved by Chesapeake IRB (#00010302).

2.2. Setting

Launched in 2008, BecomeAnEX was developed in collaboration with Mayo Clinic (McCausland et al., 2011) in accordance with national treatment guidelines (Fiore et al., 2008). BecomeAnEX teaches problem-solving and coping skills to quit smoking, educates users about cessation medications, and facilitates social support through a large social network of current and former smokers (Zhao et al., 2016). A national mass media campaign (Graham, Cha, Cobb, et al., 2013; McCausland et al., 2011; Vallone, Duke, Cullen, McCausland, and Allen, 2011) and online advertising have resulted in over 800,000 registered users since the launch of the site. To register on the site, individuals must agree to the Privacy Policy which states that 1) BecomeAnEX collects information about users and their use of the site; and 2) information is used for research and quality improvement purposes only. All user actions are date- and time-stamped. Thus, data from all registered users was available for analysis. Data were stripped of all personally identifiable information, such as email or phone number, prior to analysis.

2.3. Participants & procedures

The trial protocol (Graham, Cha, Papandonatos, et al., 2013), characteristics of the trial sample (Cha, Erar, Niaura, & Graham, 2016), and impact of the intervention arms in increasing treatment utilization (Graham et al., 2017) and abstinence (Graham et al., 2018) have been published elsewhere. Briefly, new registrants on the BecomeAnEX website (WEB) were recruited to test the individual and combined effects of two strategies to improve treatment adherence and cessation outcomes: 1) a social network approach (SN) to integrate study participants into the BecomeAnEX social network via direct outreach from longstanding members who were recruited to the study team; and 2) a 4-week supply of free nicotine replacement therapy (NRT) mailed to participants. Eligibility criteria were US residence, current smoking (every day, some days), age 18 or older, and no contraindications for NRT use per labeling instructions. In a 2 × 2 factorial design, $N = 5290$ participants were randomized to WEB, WEB + SN, WEB + NRT, or WEB + SN + NRT. Participants had access to BecomeAnEX through the final follow-up at 9 months; however, the SN and NRT interventions occurred prior to the 3-month assessment. Participants were compensated $20 for surveys completed via web, and $15 for surveys completed via telephone.

2.4. Sources of data and measures

Baseline measures include demographic characteristics (age, gender, race, ethnicity, education), cigarettes smoked per day, time to first cigarette in the morning as a measure of cigarette dependence (Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991), history of smoking-related illness, desire and confidence to quit (1 = not at all, 5 = very much), and intention to use NRT (1 = no, definitely will not, 4 = yes, definitely will). Attitudes/beliefs about NRT were assessed with 11 items from existing instruments (Bansal, Cummings, Hyland, & Giovino, 2004; Ferguson et al., 2011). On a 4-point Likert scale (1 = strongly disagree; 4 = strongly agree), participants rated agreement with statements about NRT products such as “NRT products taste bad” and “NRT products are too expensive.”

The 3-month follow-up survey was administered online, with telephone follow-up for online non-responders and incentives to maximize response rates. The main dependent variable in these analyses was any self-reported use of any NRT (study provided or self-purchased) in the past 3 months. Automated tracking data on number of website visits