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The Role of Seed Users in Nurturing an Online Health Community for Smoking Cessation Among People With HIV/AIDS

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Abstract

Background To nurture a new online community for health behavior change, a fruitful strategy is to recruit "seed users" to create content and encourage participation.

Purpose This study evaluated the impact of support from seed users in an online community for smoking cessation among people living with HIV/AIDS and explored the linguistic characteristics of their interactions.

Methods These secondary analyses examined data from a randomized trial of a smoking cessation intervention for HIV+ smokers delivered via an online health community (OHC). The analytic sample comprised n = 188 participants randomized to the intervention arm who participated in the community. Independent variables were OHC interactions categorized by participant interlocutor type (study participant, seed user) and interaction type (active, passive). The primary outcome was biochemically verified 7-day abstinence from cigarettes measured 3 months post-randomization; 30-day abstinence was examined for robustness.

Results Logistic regression models showed that participants' interactions with seed users were a positive predictor of abstinence but interactions with other study participants were not. Specifically, the odds of abstinence increased as the number of posts received from seed users increased. Exploratory linguistic analyses revealed that seed users wrote longer comments which included more frequent use of "we" and "you" pronouns and that study participants users used more first-person singular pronouns ("I").

Conclusions Seeding a community at its inception and nurturing its growth through seed users may be a scalable way to foster behavior change among OHC members. These findings have implications for the design and management of an OHC capable of promoting smoking cessation.

Lay summary

Online health communities (OHCs) are a popular means for people with similar health concerns to exchange information and support. The success of OHCs depends on members' active participation and on the formation of meaningful relationships. Jumpstarting a new OHC with active members (seed users) can promote engagement and foster its growth. Using data from a multisite randomized controlled trial of a web-based smoking cessation intervention developed specifically for people living with HIV/AIDS (PLWH), we examined whether support provided by seed users in the OHC was a stronger predictor of abstinence from smoking compared with support from other tobacco users who are also trying to quit. These secondary analyses focused on 188 urban, predominantly Black PLWH who smoked that were randomized to the intervention arm and participated in the online community. The primary outcome was biochemically verified 7-day abstinence from cigarettes measured 3 months following study enrollment. Receiving support from seed users was a positive predictor of abstinence among smokers in the trial whereas interactions with other study participants did not relate to abstinence. These findings suggest that for a new OHC, seed users can be critical for generating engagement and promoting health behavior change.

Keywords Online community · Social support · HIV · Tobacco · Smoking cessation · Text analytics

Introduction

For several decades, online health communities (OHCs) have been a popular means for people with similar health concerns to exchange information and support anonymously and with few limitations related to geography or time [1, 2]. The Internet provides easy, round-the-clock access to "expert" patients who can provide firsthand experiences about what to expect, empathic support, and practical advice [3–5]. OHCs provide access to a support network that is likely much larger than one's personal social network [6]. Support received within an OHC can differ from and be more powerful than support provided by friends or family members because OHC members share similar health concerns that may not be well understood or appreciated by others [7]. Finding and forming interpersonal relationships with similar others can create a powerful sense of belonging, acceptance, empowerment, and camaraderie, and can reduce feelings of stigma [8, 9]. Previous research has demonstrated that social support obtained from OHCs is associated with higher levels of online engagement [10, 11] and better psychological and physical outcomes [9, 12–15].

Sustainable and supportive OHCs depend on members' active participation and on the formation of meaningful long-term relationships [16, 17]. Building an online community de novo requires community management strategies, dedicated resources, and expertise [18] that evolve over time as a community moves through different developmental phases. The majority of fledging online communities often languish with little or no activity [18]. For communities in the inception phase [19], a key strategy to foster activity and nurture growth is to recruit "seed users" to create content to promote community engagement prior to its launch. Seed users start discussions, respond promptly to members' posts, proactively reach out to new members to establish connections, and encourage members to post [20, 21]. Seeded content can ensure that a fledgling community appears active to new members and proactive outreach can be welcoming to new members. These activities are especially important in a research context where the typical pace of participant recruitment often means that small numbers of study participants will trickle into an online community space over time and experience "multiple threads with few messages and last-post dates that are long past" [18]. Not only is this a poor user experience, but it would also fail to be a true test of the impact of online community support. While the role of seed users in promoting online activity and engaging early users in an OHC has been well documented [18], it remains unknown if such interactions are associated with positive health outcomes. This was the first area of inquiry in this study.

The second area of inquiry in this study relates to the content of online interactions and specific linguistic features which may affect communication and social support outcomes. Previous research has shown that word categories can reveal individuals' attentional focus [22], and the change of linguistic features and topics of discussions has emerged as a predictor of user online activities [22–26]. In particular, pronouns communicate identities and relationships [27]. A subtle shift in pronouns can initiate powerful changes in people's emotions, behaviors, and connections [28]. According to Scheibman's theory on inclusion [29, 30], the use of the first-person plural pronoun "we" can signal a sense of group shared identity and express a belonging to the group. In contrast, using the first-person singular pronoun "I" is related to an independent or individualist self [31, 32]. People who are experiencing physical or emotional pain tend to use more first-person singular pronouns [33]. In addition, the second-person pronoun "you" refers to people in general [34, 35], which is more likely to evoke a sense that the message speaks directly to the recipient and promote enhanced involvement [23, 36]. For face-to-face communications, the use of pronouns—especially more frequent use of "we"—is associated with higher abstinence rates among alcohol users [37]. To date, there has been little research on whether the communications of seed users and regular members of OHCs vary in meaningful ways.

We explored these questions using data from a multisite randomized controlled trial of a web-based smoking cessation intervention developed specifically for people living with HIV/AIDS (PLWH). Smoking prevalence is dramatically higher among PLWH than the general population (34%–53% vs. 14%) and quit rates are lower [38]. Many people survive HIV/AIDS only to die from a tobacco-related illness, making the development of effective smoking cessation interventions for PLWH a public health priority [39, 40]. Previous research has shown that social support from peers and higher online social network integration are associated with increased attempts to quit smoking, decreased cigarette consumption, and lower relapse rates [14, 41–47]. These findings are especially pertinent for PLWH given than loneliness is an important driver of smoking behavior among PLWH [48] and many also struggle with isolation and stigma related to their diagnosis [49].

The parent trial demonstrated that a smoking cessation intervention tailored to the needs of PLWH anchored around an OHC was more effective in promoting abstinence than a standard care control. The intervention integrated evidence-based and theory-driven didactic content into an OHC [50–53]. The community was launched prior to study initiation to create an active, meaningful, and supportive online community experience for all study participants. Seed users (current or former smokers with HIV/AIDS from clinical sites) were recruited to be part of the study team prior to participant recruitment. Their role was to foster cessation-related discussions, provide timely responses to study participants' posts, and encourage engagement with the didactic content of the intervention. Given the expected rate of study recruitment (~2 people per week) combined with the fact that 90% of individuals in an OHC choose to "lurk" rather than post [54], we anticipated that research participants would be most likely to interact with seed users in the OHC and have fewer interactions with fellow study participants. Analyses from the parent trial showed higher biochemically verified abstinence rates at the 6-month follow-up compared with a seven-session health-promotion control website offered by the American Heart Association without an OHC (14.9% vs. 8.8% [55]). The findings were robust across a range of cessation outcomes, using models that controlled for potential confounders. Although abstinence rates were low overall, these findings are notable since no prior U.S. study of Internet-based tobacco cessation treatment in PLWH has shown efficacy at ≥6 months. Furthermore, the study demonstrated the efficacy of an Internet-based program with an online support community in a low SES (socioeconomic status) and poorly educated cohort.

This article builds on findings from the parent trial to understand the potential contributions of the OHC in promoting abstinence. We addressed two research questions

specific to the impact of seed users: (RQ1) Is support provided by seed users in an OHC for smoking cessation a stronger predictor of abstinence compared with support from other tobacco users who are also trying to quit? (RQ2) Do seed users provide support in a way that is linguistically different from other members? Answers to these questions can help managers of OHCs better understand the value of seed users to OHC members and inform a robust community management strategy, especially during the early stages.

Method

This manuscript was prepared following STROBE (STrengthening the Reporting of OBservational studies in Epidemiology) guidelines. The parent study was approved by the IRBs at Montefiore Medical Center's and Johns Hopkins University School of Medicine and these analyses were approved by Advarra Institutional Review Board. Informed consent was obtained from all participants included in the study.

Data

Data were collected as part of a randomized controlled trial (NCT02781090) to evaluate the effectiveness of Positively Smoke Free on the Web (PSFW+), a mobile-optimized, multimodal, interactive, and web-based smoking cessation intervention hosted within an OHC created specifically for PLWH who smoke. The community was hosted on a third-party platform (Vanilla Forums, Inc.). The educational content (delivered via static web content and video) was integrated into the online community. Participants could post personal reactions and insights related to lesson themes, share their experience with quitting, or connect with other community members about any topic. Responses could also take the form of emojis. The program enabled participants to select and reset their quit date at any time. Intervention engagement was promoted via text-message and email reminders that users could request during study enrollment.

Between July 2016 and March 2020, participants were enrolled into the trial at Montefiore Medical Center's Center for Positive Living in the Bronx, New York, and at Johns Hopkins Bartlett Clinic for Infectious Diseases in Baltimore, Maryland. Inclusion criteria were: (i) laboratory confirmed HIV infection, (ii) current cigarette smoker (affirmative responses to "Have you smoked at least 100 cigarettes in your entire life?" AND "Have you smoked cigarettes (even a puff) in the last seven days, including today?"), (iii) motivation to quit smoking in the next 6 months, (iv) at least weekly Internet access, (v) at least seventh grade reading level, (vi) no contraindications to nicotine patch use, and (vii) not pregnant or breastfeeding. Following eligibility screening and informed consent, individuals completed a baseline assessment that included demographic and tobacco use characteristics. The final study consisted of 255 individuals randomized to Intervention and 251 randomized to Control. All trial participants were offered a 12-week course of nicotine patches dosed according to average daily cigarette intake at study enrollment. Results from the parent trial have been previously published [55]. Among the 255 participants randomized to Intervention, 188 were active in the community and thus comprise the analytic sample for these secondary analyses.

Seed users were seven people with HIV/AIDS who were current or former smokers. They were recruited by study personnel at each of the clinical sites. Clinical staff at the study sites informed the clinics' provider panels of the opportunity to refer their patients to be considered for the role of paid seed users during the trial. Care providers were urged to refer candidates who were living with HIV, had either quit smoking cigarettes or were trying to quit, had access to the Internet, were willing and able to check in on the website daily and post messages as needed, and had the literacy and computer literacy skills to fulfill these responsibilities. Among seed users, four had quit smoking before the start of the study and three were smoking at study inception. Seed users were trained in the use of the online community platform and instructed to create original content based on their lived experience as a tobacco user (current or former) living with HIV/AIDS and to respond to posts from study participants. They were paid a modest monthly stipend if they posted in the community on 20 or more days of the month. Seed users were instructed to refrain from mentioning their official role as part of the study team in the community. A professional community manager oversaw the work of seed users, held monthly supervision meetings with seed users, addressed any software issues, monitored site usage, and responded to any community issues.

Measures

Smoking outcomes

All trial participants were scheduled to attend follow-up visits at 4-, 12-, and 24-week post-randomization. Participants self-reported smoking status at each follow-up ("Have you smoked a cigarette, even a single puff, in the past seven days?"), which was followed by biochemical verification via exhaled carbon monoxide measurement for those who reported 7-day abstinence. Exhaled carbon monoxide <10 ppm was considered to be in the nonsmoker range, a standard methodology in tobacco treatment trials at the time the trial was designed [56]. Biochemically verified 7-day abstinence at the 12-week follow-up assessment was the primary outcome in these secondary analyses. The 12-week assessment was selected because most user activity occurred within that period. Participants also reported past 30-day smoking ("Have you smoked a cigarette, even a single puff, in the past 30 days?"), which we used to conduct robustness checks of the primary analyses. Outcomes assessors and investigators were blinded to group assignments; neither the study coordinator nor participants were blinded.

OHC interactions among study participants and seed users

Independent variables were metrics reflecting study participants' online interactions with other OHC members. Interactions were categorized based on two dimensions: (i) whether a study participant's interlocutor was another study participant or a seed user, and (ii) whether a study participant was actively posting/interacting with another user (i.e., initiating a thread or commenting on a thread that was initiated by another user) or passively receiving support from someone who responded to them (i.e., receiving a comment from another user, receiving an emoji response to a post, or being mentioned by others in a post). When counting passive interactions, we excluded responses to a study participant's post that occurred after their last recorded login to ensure they had seen the response. Based on these definitions, we calculated the following metrics for each study participant (SP) based on their first 3 months of online activity:

(1) *#INT_SP*: total number of interactions a study participant had with other study participants
(2) *#INT_seed*: total number of interactions a study participant had with seed users
(3) *#INT-ACTIVE_SP*: number of active interactions with other study participants
(4) *#INT-ACTIVE_seed*: number of active interactions with seed users
(5) *#INT-RECEIVED_SP*: number of interactions received from other study participants
(6) *#INT-RECEIVED_seed*: number of interactions received from seed users

To calculate these variables, we exported back-end data for all interactions between and among study participants and seed users from the Vanilla Forums database during the first 3 months following each study participant's study enrollment. Seed user activity in the community began 1 month prior to study recruitment; study participants had access to the Intervention for 6 months post-randomization. The dataset spanned June 2016 to September 2020.

Control variables

Described previously, the baseline assessment in the parent study included demographic, psychosocial, and smoking characteristics [55]. Based on prior smoking cessation research, we included the following as control variables given their links to treatment effectiveness: gender (male, female), race (Black, not Black), employment status (employed, not employed), marital status (married, not married), cohabitation with another smoker (yes/no), and nicotine dependence (low, low/moderate, moderate, high [57]).

Statistical Analyses

We began by characterizing the analytic sample using descriptive statistics on the control variables. To address RQ1, we first examined whether the numbers of interactions with study participants or seed users predicted abstinence from smoking using logistic regression (Model 1). A second logistic regression model (Model 2) examined social support from seed users and study participants based on whether interactions were active or passive. To address RQ2, we examined the way that study participants and seed users delivered support by comparing linguistic characteristics of their posts using Linguistic Inquiry and Word Count (LIWC). LIWC, a computer program for dictionary-based quantitative text analysis, has been widely used to capture linguistic features from text data across diverse research areas in sociology and psychology [22, 58]. Our analysis focused on sixteen LIWC categories, which included word count and standard linguistic dimensions (e.g., word frequencies of first-person singular/plural pronouns). We then conducted Mann–Whitney *U*-tests to compare the differences of linguistic characteristics between seed users and study participants.

Results

Sample Characteristics

The sample was 39.4% female, 84.0% Black, 13.8% White, and 18.1% Latino. At baseline, roughly half of participants had high (10.1%) or moderate (43.9%) levels of nicotine dependence. At the 12-week follow-up, 18.1% (34 of 188) reported 7-day abstinence and were biochemically confirmed to be abstinent and 13.3% (25 of 188) reported 30-day abstinence.

(RQ1) Is Support Provided by Seed Users in an OHC a Stronger Predictor of Abstinence Compared With Support From Fellow Study Participants?

Table 1 lists the OHC engagement variables and their summary statistics. The most common type of interaction for study participants was to receive an interaction from a seed user. The number of interactions that study participants received from seed users was greater than the number of interactions they received from other study participants, and also greater than the number of their active interactions with other users (study participant or seed users combined). No Pearson correlation coefficient among variables was higher than 0.6 and all Variance Inflation Factor values were lower than 2, suggesting low-to-moderate multicollinearity. Because the distributions of variables related to OHC interactions were highly skewed, we used log-transformed values of all six variables in regression analyses. We standardized all control variables and independent variables with *Z*-scores to better observe how changes in independent variables affected the primary outcome.

As shown in Table 2, the positive and marginally significant effect of *#INT_seed* in Model 1 shows that support from seed users was positively related to 7-day abstinence at the 12-week follow-up. There was a 50.5% ($e^{0.409} - 1 = 0.505$) increase in the odds of abstinence for a one-unit increase (in log space) in interactions with seed users, which translates

Table 1 Descriptive Characteristics of Online Interactions Among Study Participants (*n* = 188) and Seed Users (*n* = 7)

Variable	Median (IQR)	Mean (*SD*)	Min, Max
#INT_SP	1 (0–7)	7.42 (15.09)	0, 103
#INT_seed	6 (4–11)	13.72 (21.78)	0, 163
#INT-ACTIVE_SP	0 (0–2)	3.55 (10.84)	0, 78
#INT-ACTIVE_seed	0 (0–1)	2.32 (8.63)	0, 76
#INT-RECEIVED_SP	0 (0–4)	3.86 (8.61)	0, 52
#INT-RECEIVED_seed	6 (4–11)	11.39 (15.87)	0, 102

#INT_SP: total number of interactions a study participant had with other study participants.
#INT_seed: total number of interactions a study participant had with seed users.
#INT-ACTIVE_SP: number of active interactions a study participant had with other study participants.
#INT-ACTIVE_seed: number of active interactions a study participant had with seed users.
#INT-RECEIVED_SP: number of interactions a study participant received from other study participants.
#INT-RECEIVED_seed: number of interactions a study participant received from seed users.

to 25 posts on average. Interactions with other study participants were not significantly related to abstinence. Model 2 revealed that, more specifically, support received from seed users was the only significant and positive predictor of abstinence among the four support variables in the model. There was a 70.2% increase ($e^{0.532}$ – 1=0.702) in the odds of abstinence for a one-unit increase (in log space) in support received from seed users. All models yielded numerically consistent effects from control variables. Marital status was the only control variable to positively and significantly predict abstinence across all models. Black race was a numerically negative predictor of the primary outcome, and a significantly negative predictor across all three models of the secondary analysis.

As shown in Table 3, analyses using 30-day point prevalence abstinence at 12 weeks as the outcome of interest yielded findings consistent with our main analysis such that support from seed users predicted study participant abstinence.

(RQ2) Do Seed Users Provide Support in a Way That Is Linguistically Different From Other Members?

As shown in Table 4, seed users wrote longer comments than those of study participants (median number of words = 29, IQR = 31 vs. median = 13, IQR = 26, $p < .001$). In turn, these longer comments provided more space to include conjunctions, which were more common among posts from seed

Table 2 Logistic Regression Models Predicting 7-Day Point Prevalence Abstinence at 12 Weeks (n = 188)

	Model 0	Model 1	Model 2
Intercept	−0.879 (0.804)	−0.762 (0.812)	−0.729 (0.819)
Control variables			
Marital status	1.265 (0.469)**	1.433 (0.508)**	1.348 (0.519)**
Cohabitation with another smoker	−0.394 (0.476)	−0.499 (0.491)	−0.433 (0.506)
Gender	−0.121 (0.403)	−0.204 (0.422)	−0.225 (0.428)
Race	−0.917 (0.479)	−0.923 (0.489)	−1.038 (0.503)*
Employment	0.587 (0.510)	0.466 (0.523)	0.422 (0.531)
Nicotine dependence	−0.050 (0.223)	−0.087 (0.224)	−0.072 (0.224)
Independent variables			
log #INT_SP		−0.236 (0.234)	
log #INT_seed		0.409 (0.214) (i)	
log #INT-ACTIVE_SP			−0.296 (0.246)
log #INT-ACTIVE_seed			−0.238 (0.258)
log #INT-RECEIVED_SP			0.099 (0.236)
log #INT-RECEIVED_seed			0.532 (0.248)*

Note: (i) $p < .10$;
*$p < .05$;
**$p < .01$; (ii) *SEs* are in parentheses.

Table 3 Logistic Regression Models Predicting 30-Day Point Prevalence Abstinence at 12 Weeks (n = 188)

	Model 0	Model 1	Model 2
Intercept	−0.521 (0.881)	−0.402 (0.892)	−0.404 (0.899)
Control variables			
Marital status	1.302 (0.517)*	1.450 (0.554)**	1.353 (0.569)*
Cohabitation with another smoker	0.139 (0.511)	0.065 (0.525)	0.139 (0.542)
Gender	−0.282 (0.464)	−0.367 (0.488)	−0.381 (0.495)
Race	−1.204 (0.525)*	−1.227 (0.537)*	−1.322 (0.553)*
Employment	0.793 (0.553)	0.663 (0.571)	0.610 (0.582)
Nicotine dependence	−0.347 (0.257)	−0.390 (0.257)	−0.367 (0.257)
Independent variables			
log(#INT_SP)		−0.257 (0.266)	
log(#INT_seed)		0.471 (0.245).	
log(#INT-ACTIVE_SP)			−0.291 (0.281)
log(#INT-ACTIVE_seed)			−0.243 (0.296)
log(#INT-RECEIVED_SP)			0.061 (0.268)
log(#INT-RECEIVED_seed)			0.610 (0.289)*

Note: (i) $p < .10$.
*$p < .05$;
**$p < .01$; (ii) *SEs* are in parentheses.

Table 4 Linguistic Characteristics of Support Received From Seed Users Versus Study Participants[a]

Linguistic characteristics	Support from other study participants		Support from seed users	
	Mean (*SD*)	Median (IQR)	Mean (*SD*)	Median (IQR)
Word count	38.95 (109.56)	13.00 (26.00)	**42.07 (44.67)*****	29 (31.00)
Standard linguistic dimensions (word frequencies)				
Total function words	50.75 (16.14)	53.66 (14.55)	51.84 (14.75)	55.56 (14.76)
Total pronouns	18.01 (10.51)	18.64 (7.93)	17.70 (8.02)	18.18 (9.91)
Personal pronouns	12.04 (8.44)	12.28 (12.09)	11.85 (6.67)	11.76 (8.44)
First-person singular (I)	**8.78 (7.93)*****	9.09 (13.70)	3.23 (4.82)	0 (5.56)
First-person plural (we)	0.25 (1.78)	0 (0)	**1.15 (2.89)*****	0 (0)
Second person (you)	2.74 (6.19)	0 (0)	**6.92 (5.84)*****	5.88 (8.37)
Third-person singular (she, he)	0.12 (0.95)	0 (0)	0.20 (1.18)	0 (0)
Third-person plural (they)	0.16 (0.98)	0 (0)	0.35 (1.22)	0 (0)
Impersonal pronouns (it, it's, those)	5.96 (8.05)	4.55 (9.09)	5.84 (5.12)	5.66 (8.70)
Articles (a, an, the)	4.07 (4.97)	3.03 (6.85)	3.83 (3.76)	3.57 (6.00)
Prepositions (to, with, above)	11.94 (8.07)	11.86 (8.98)	12.00 (6.13)	12.12 (7.22)
Auxiliary verbs (am, will, have)	11.03 (10.31)	9.38 (11.99)	10.00 (6.67)	10 (7.76)
Common adverbs (very, really)	5.46 (6.06)	5.26 (8.47)	4.60 (4.77)	4.19 (6.98)
Conjunction (and, but, whereas)	4.32 (5.04)	2.44 (7.32)	**5.35 (4.34)***	5.41 (8.16)
Negations (no, not, never)	1.66 (3.71)	0 (1.95)	1.59 (2.66)	0 (2.72)

[a]Numbers in bold indicate the main differences of linguistic characteristics between seed users and study participants.
Note:
*$p < .05$;
***$p < .001$.

users than study participants (5.35 ± 4.34 vs. 4.32 ± 5.04, $p < .05$). In addition, compared with study participants, seed users used more "we" (1.15 ± 2.89 vs. 0.25 ± 1.78, $p < .001$) and "you" (6.92 ± 5.84 vs. 2.74 ± 6.19, $p < .001$) pronouns. In contrast, study participants used more first-person singular pronouns ("I") compared with seed users (8.78 ± 7.93 vs. 3.23 ± 4.82, $p < .001$).

Discussion

This study examined the role of seed users in an OHC in promoting health behavior change. We analyzed data from a seeded OHC created for a randomized clinical trial for smoking cessation among an urban and largely Black population of PLWH. The online community was initiated prior to study inception to ensure a robust and meaningful community experience for all study participants without having to wait for study recruitment to create a critical mass of activity. Analyses centered on the contributions of seed users and fellow study participants in promoting abstinence, and differences in linguistic styles between these two groups.

Two key findings emerged. The first was that receiving support from seed users was a positive predictor of abstinence among smokers in the trial. Specifically, the odds of abstinence increased as the number of posts received from seed users increased. While the effect of interactions with other study participants was not significant in the model, this does not necessarily suggest that support from other smokers trying to quit in an OHC is not beneficial for health outcomes. Instead, these results suggest that for a new OHC with a small user base, the role of seed users at this early stage can be very important, not only in generating more online participation, but also in promoting health behavior change. These findings also align with the framework proposed by Cole-Lewis et al. [59] in which engagement in a digital behavior change intervention ("Little e")—in this case, social interactions in the online community—were linked to health behavior engagement ("Big E")—in this case, smoking cessation.

The second key finding was that study participants and seed users delivered support in linguistically different ways. Seed users wrote messages that were roughly twice as long as those authored by study participants, and their posts were more inclusive with more frequent use of the first-person plural pronoun "we." This style may have encouraged study participants to become involved in the OHC and contributed to a sense of shared community. In contrast, study participants' contributions to the OHC were more egocentric, with greater use of first-person singular pronoun "I" likely as they shared their experiences quitting smoking as part of the trial.

These findings have several implications for the management of OHCs and their role in public health. The parent trial demonstrated the effectiveness of a smoking cessation intervention delivered through an OHC in promoting abstinence among a largely underserved, patient population at high risk for smoking and other substance use. Analyses presented in this article suggest that engagement with seed users may have played an important role in producing that treatment effect. For individuals who want to quit smoking, our findings show that being actively engaged in an OHC may be associated with abstinence. Given proactive outreach from seed users, a study participant does not have to publish many posts to receive the information and support that he/she needs to quit. Creating and sustaining an engaged group of core members is central to the success of any online community and can be done cost efficiently through a volunteer corps or paid members as in this trial [18]. Indeed, the presence of

a core group of members that have become invested into the community's longevity and growth and stay active to "pay it forward" is a hallmark of a mature community [19, 60]. Furthermore, the linguistic differences observed suggest that seed users' posts were more successful at establishing a communal sense of identity through inclusive language than those of study participants, which may provide a mechanism for the significant effect of seed users' posts on abstinence. Future research should further investigate that hypothesis. Program designers, researchers, and community managers looking to jumpstart an OHC by recruiting seed users prior to its launch should consider coaching seed users about the importance of inclusive linguistic styles.

Several limitations of this research should be noted. First, given the observational nature of the data, we cannot make causal statements about the influence of online interactions in an OHC and behavior change. Second, these analyses focused on quantitative metrics of OHC interactions and did not consider the content of posts in understanding the impact on abstinence. Future analyses might blend a broader set of metrics into analyses that consider both quantitative and qualitative aspects of OHC interactions. Finally, this study was conducted in the context of a randomized clinical trial that tested the effectiveness of an intervention approach anchored around an OHC for smoking cessation. Several aspects of the trial may limit the generalizability of the findings to an OHC run in the context of a research study versus one operating at scale "in the wild." Interactions among study participants were limited given the pace of study recruitment, patients were referred by their providers following an in-person onboarding session, and study participants received incentives for completing study assessments at various follow-up intervals. Evaluating the generalizability of these results in other contexts, platforms, and health behavior domains is a topic for additional research.

In the rapidly expanding digital health landscape, "peer-to-peer healthcare" has come to play an increasingly important role [61, 62]. This study demonstrates that it is possible to create an active and impactful OHC in the context of a randomized clinical trial for smoking cessation and provides new insights into the types of interactions that support behavior change. Seeding a community with content at its inception and nurturing its growth through ongoing engagement and proactive outreach from seed users may be a cost-efficient and scalable way to positively impact behavior change among OHC members.

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Compliance with Ethical Standards

Authors' Statement of Conflict of Interest and Adherence to Ethical Standards Amanda L. Graham and Michael S. Amato are employed by Truth Initiative, a nonprofit public health foundation which sells enterprise digital tobacco cessation programs to support its mission-driven work. Xiangyu Wang, Kang Zhao, Cassandra A. Stanton, and Jonathan Shuter declare that they have no conflict of interest.

Authors' Contributions Xiangyu Wang (Conceptualization [supporting], Formal analysis [lead], Methodology [lead], Writing – original draft [lead], Writing – review & editing [equal]), Kang Zhao (Conceptualization [supporting], Formal analysis [supporting], Methodology [supporting], Supervision [lead], Writing – review & editing [equal]), Michael S Amato (Conceptualization [equal], Methodology [supporting], Writing – review & editing [equal]), Cassandra A Stanton (Funding acquisition [lead], Writing – review & editing [supporting]), Jonathan Shuter (Funding acquisition [lead], Writing – review & editing [supporting]), and Amanda L Graham (Conceptualization [lead], Funding acquisition [supporting], Writing – review & editing [lead])

Ethical Approval All procedures performed were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Transparency Statements *Study registration*: The parent study was preregistered at ClinicalTrials.gov (NCT02781090). *Analytic plan preregistration*: The plan for these secondary analyses was not formally preregistered. *Analytic code availability*: Analytic code used to conduct the analyses in this study is not available in a public archive. They may be available by emailing the corresponding author. *Materials availability*: Materials used to conduct the study are not publicly available.

Data Availability

Deidentified data from this study are not available in a public archive. Deidentified data from this study will be made available (as allowable according to institutional IRB standards) by emailing the corresponding author.

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