Weekly enrollment and usage patterns in an Internet smoking cessation intervention

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ABSTRACT

Background: Previous analyses of Google search queries identified circaseptan (weekly) rhythms in smoking cessation information seeking, with Google searches for "quit" and "smoking" peaking early in the week. Similar patterns were observed for smoking cessation treatment seeking, such as calls to quitlines. These findings suggest that smoking cessation behaviors may have a weekly rhythm that could be leveraged to improve smoking cessation efforts.

Aims: To assess whether weekly enrollment and usage patterns exist for an Internet smoking cessation intervention.

Methods: We used process data from a large, longstanding Internet smoking cessation intervention (www.becomeanex.org). Pearson's chi-squared tests were performed to identify day-of-the week differences in enrollment, first visit to site community pages, and quit date. Differences were considered statistically significant at the 1% level if $p < 0.00167$ due to multiple comparisons. Regression analysis was used to examine differences in engagement activity based on the day of the week a user enrolled.

Results: Website users ($n = 69{,}237$) were more likely to enroll on the site at the beginning of the week (Mondays and Tuesdays) ($p < 0.0001$). Current smokers who selected quit dates ($n = 5574$) preferred quit dates that came early in the week (Sundays and Mondays) compared to other weekdays ($p < 0.0001$). Generally, there were no significant differences in overall website utilization metrics by day of enrollment, but there were some exceptions. Use of interactive features to select quit dates, track cigarette use, and record coping strategies was generally lower for Friday/Saturday enrollees.

Conclusions: Consistent with prior research, the beginning of the week appears to be a time when individuals are more likely to enroll in an Internet smoking cessation intervention and engage with its core features. Emphasizing marketing and promotional efforts during the beginning of the week could result in greater reach of Internet smoking cessation interventions.

1. Introduction

In the United States, 68.8% of smokers are interested in quitting (Babb et al., 2017), with two-thirds of all adult smokers making a past year quit attempt (Lavinghouze et al., 2015). However, smokers are often unsuccessful in their attempts to quit. In 2010, the six-month point prevalence of smoking abstinence was only 6.2% (Centers for Disease Control and Prevention, 2011). Novel and cost-effective smoking cessation treatment strategies that have the capacity to reach

and engage large numbers of smokers are needed to reduce smoking prevalence.

Public health campaigns that promote Mondays as a day for smokers to quit and recommit to quitting can augment current approaches to smoking cessation. A number of studies suggest that the beginning of the week represents a time when interest and engagement in health behavior change may peak. A study by Ayers et al. (2014a) found that Google search queries for the term "healthy" between 2005 and 2012 showed a pronounced early week spike with Monday and Tuesday

having about 200% more queries than any of the other days of the week. A separate analysis of Google searches for the term "diet" yielded similar results with searches occurring most frequently at the beginning of the week, month, and year (Dai et al., 2014). Day-of-the-week variation has also been observed in weight loss rhythms and physical activity behaviors. Orsama et al. (2014) identified weekly weight rhythms among participants who lost weight. Participants tended to weigh the least on Fridays and the most on Sundays or Mondays. Similarly, Dai et al. (2014) identified fluctuations in gym attendance at an undergraduate institution with attendance at its highest at the beginning of the week and tapering throughout the week.

To observe day-of-the week patterns specific to smoking cessation, Ayers et al. (2014b) used Google's public query archive (google.com/trends) global daily relative search volumes to assess smoking cessation related searches (e.g., "quit" and "smoking") from 2008 to 2012. Cessation queries peaked early in the week, declining through Saturday with a modest Sunday rebound. Similar early week patterns have been observed in quitline usage. Calls to the Victoria, Australia quitline from August 1, 2000 through July 31, 2001 peaked Monday to Wednesday, with calls occurring on each of these days with a frequency that was three times that of Sundays (Erbas et al., 2006). In the United States, Johnson (2011) sampled 16 state quitlines and noted increased call volumes at the beginning of the week and decreased volumes at the end of the week. Collectively, these studies suggest that health information seeking behaviors may have a weekly rhythm which could be leveraged to increase the overall population impact of behavior change interventions.

The goal of this study was to build on previous analyses to determine if day-of-the-week engagement patterns with a smoking cessation intervention extend beyond search engine queries and quitline calls to the Internet. Hundreds of thousands of smokers register on Internet smoking cessation programs each year (Balmford et al., 2009; McCausland et al., 2011; Nash et al., 2015; van Mierlo et al., 2012), making them an ideal environment to study patterns of health information seeking and treatment uptake. Internet smoking cessation interventions can reach large numbers of smokers, are highly scalable, and have been shown to yield quit rates comparable to other intervention modalities (Civljak et al., 2013; Graham et al., 2016). If day-of-the-week patterns are present for enrollment in these kinds of programs, it could represent a potential lever to further expand their reach through marketing and promotion efforts targeted on day-of-the-week. Likewise, if day-of-the-week patterns are present for engagement in Internet smoking cessation programs, this could inform [relatively simple] ways to increase engagement by capitalizing on natural variations in treatment utilization. Identifying approaches to increase either the reach and/or effectiveness of Internet interventions – and understanding the subsets of users for whom such approaches may be most effective – is critical to optimizing their potential impact. This paper examines if enrollment, quit date selection, and use of the online community were more frequent earlier in the week. We also investigate whether the use of site features varied by the day of the week a user enrolled.

2. Material and methods

2.1. Intervention

We examined data from BecomeAnEX.org, a free, publicly-available Internet smoking cessation program, developed and managed by Truth Initiative (Richardson et al., 2013; McCausland et al., 2011). BecomeAnEX provides guidance on quitting, an interactive quit plan, and a large and active online community. The content of the site was developed in partnership with the Mayo Clinic Nicotine Dependence Center and is consistent with national treatment guidelines for treating tobacco dependence (Fiore et al., 2008). BecomeAnEX provides problem-solving and skills training designed to enhance self-efficacy through a series of interactive exercises and didactic content; help in selecting and using FDA-approved smoking cessation pharmacotherapies; and intra-treatment social support in the form of a large online community. The site also employs a series of email campaigns to keep users engaged with the site. Emails were only sent to users who opted in to receive email from BecomeAnEX. The email campaigns included a welcome series, a quit date series, and a reactivation series that attempted to bring users back to the site if they became inactive. All user actions on the website are stored in a relational database with timestamps. Specifically of interest in the current investigation were date-based actions that users took on the site, such as setting a quit date. We were also interested in interactions with the online community given previous research that has demonstrated its links to ongoing website utilization and abstinence (Graham et al., 2015; Papandonatos et al., 2016; Richardson et al., 2013).

2.2. Recruitment and registration process

The data used in these analyses were collected from September 1, 2011 through February 29, 2012. This period was selected because there were no research studies running and thus the registration process and utilization metrics reflect the experience of typical users. During this time, BecomeAnEX was supported by a comprehensive national online advertising campaign which included banner ads and search engine ads using a cost-per-click model. Spending for the advertising campaign remained static on a month-to-month basis and was evenly distributed throughout the week. Clicking on an ad took users to a landing page associated with the ad (i.e., same imagery, call to action phrasing). Registration included personal information (name, username, password), demographic information (gender, race, ethnicity), smoking history (current smoking status, reasons for quitting), and source of recruitment (where they learned about BecomeAnEX). The question about current smoking status included options to self-identify as "health professionals" or "looking for someone else" if they were not current or former smokers. All content on the website was viewable without registering, but if a user wanted to utilize the interactive tools or post in the online community, they were required to register. Following registration, users were taken to "My Quit Plan" which presented a sequence of recommended steps to prepare for cessation and tracked completed steps. The first action that the site recommended was to set a quit date, with general guidance to quit within 2–4 weeks but the flexibility to select any quit date.

2.3. Sample description

All users included in these analyses voluntarily registered on BecomeAnEX with no incentive for enrollment. Registration required users to agree with the website Terms of Service and Privacy Policy which stated that usage patterns may be reviewed for quality improvement and research purposes.

2.4. Measures

These analyses focused on website utilization metrics obtained via automated tracking software and selected information from registration data. Website utilization data were obtained via Adobe Analyst software (Adobe Systems Incorporated, 2016), a customizable web analytics tool that is used to monitor, report on, and optimize use of the website. General utilization metrics examined in this study included: number of logged in return visits, number of minutes spent on site, and the number of pages viewed. Every page view by a participant is recorded in a relational database, and page views are grouped into sessions. The duration of a session is defined as the time elapsed between the first page view and the last page view in a given session. Number of minutes spent on site is calculated by totaling the duration of all sessions within a specified time period. If a user stays on the same page for

longer than 30 min, the system marks the session as inactive and the next return visit is defined as a new session. Data were also extracted on the number of times a quit date was set and the use of interactive features. Date-stamped events were extracted for website enrollment, date of first visit to the community pages, and quit dates. Because website utilization tends to show a steep attrition after initial use (Eysenbach, 2005), we focused our analyses on utilization metrics during the first three months following site registration. Self-reported age and smoking frequency (i.e., daily, most/some days, not at all) provided during registration were also examined in these analyses.

2.5. Statistical analysis

Descriptive analyses were used to characterize users according to age, smoking frequency, number of site visits, time on site, number of page views, and to calculate the proportion of participants who set a quit date or visited the site's community pages. Variables related to the use of interactive tools were dichotomized to indicate any usage by site visitors for subsequent analyses.

Pearson's chi-squared goodness-of-fit tests and tests of independence were performed to identify day-of-the week differences in day of enrollment, day for selected quit date, and use of the online community. Given the use of multiple comparisons, we used a Bonferroni correction of 1/6 since we had six hypothetical comparisons to use for Monday (Dunn, 1961). A difference was considered statistically significant at the one-percent level if the p-value was less than 0.00167. For effect size, we reported the difference between the observed and expected frequency of an outcome variable based on a uniform distribution of Internet activity across the seven days of the week. We expected the frequency of an activity to be 14.3% if the activity was distributed evenly across the week. We also report the difference between the observed frequency of activities on Monday versus the observed frequency of activities on other days of the week.

We investigate whether the use of site features varied by the day of the week a user enrolled. Pearson's chi-squared goodness-of-fit tests were also used to identify significant differences in dichotomized community engagement variables based on the day of the week a user enrolled or selected a quit date. Again, a difference was considered statistically significant at the one-percent level if the p-value was less than 0.00167. To explore the distributional differences in day of the week enrollment and quit date selection on website utilization variables (i.e. number of visits, time on site, page views, number of community pages visited, and number of times using the cigarette tracker), Poisson, ordinary least squares, and logistic regressions (depending on the outcome variable) were run to capture relative day of the week differences. Results from these regressions were considered statistically significant at the one-percent level if the p-value was less than 0.01.

3. Results

3.1. Sample characteristics

A total of 79,328 individuals registered on the site during the study period. We excluded 892 individuals who indicated they were health professionals and 9199 individuals who indicated they were searching for information for another person. There were an additional 9079 individuals for whom this information was missing which were kept in the sample; these individuals had minimal site usage and their inclusion did not significantly change the results. The final analytic sample included 69,237 users (Table 1). Mean age of the analytic sample was 35 years (SD = 11). Sixty-two percent of users were daily smokers, 24% smoked on most days, and 8.7% were former smokers (self-identified). Users learned about the program primarily through online banner ads (21.7%), search engines (13.0%), quit lines (9.8%), and social networking sites (8.0%).

Table 1
Demographic and smoking characteristics and website utilization metrics among BecomeAnEX users ($N = 69,237$).

Variable	% (n)
Age by category[a]	
< 18	0.6 (370)
18–24	12.8 (7776)
25–34	45.9 (27,934)
35–44	19.6 (11,908)
45–54	14.0 (8492)
55 +	7.1 (4354)
Smoking frequency	
Every day	61.5 (42,602)
Most days or some days	24.4 (16,930)
Does not smoke anymore or trying to stay quit	8.7 (6006)
Not at all	3.0 (2063)
Unknown	2.4 (1636)
Number of visits to the site months 0–3, mean (SD), [range]	1.3 (6.8), [0–787]
Number of return visits months 0–3	
0 return visits	16.1 (11,148)
1 visit	74.9 (51,838)
2 visits	5.3 (3697)
3 or more visits	3.7 (2554)
Time on site in minutes months 0–3, mean (SD), [range]	10.7 (288.6), [0–59,966]
Number of page views months 0–3, mean (SD), [range]	10.2 (157.2), [0–25,223]
Set quit date[b]	8.1 (5574)
Visited community	18.3 (12,666)

[a] Age was optional at registration and was missing for 8403 users.
[b] Among current smokers.

3.2. Site usage

Among registered users, 16.1% ($n = 11,148$) did not return to the site, 74.9% ($n = 51,838$) had one return visit, and 9.0% ($n = 6231$) had more than one return visit (Table 1). Users with at least one return visit spent an average of 12.7 min on the site. Time spent on the site varied highly among all users, which is typical of website utilization patterns (Mean: 10.7 min; Range: 0–1000 h; SD: 4.8 h). Users viewed an average of 10 webpages on the site (not unique) within the first three months after enrollment. Page views also varied across users (Range: 0–25,223; SD: 157.2). The number of visits to the site, time on site, and number of page views variables were positively skewed.

3.3. Website enrollment and engagement patterns by day of the week

3.3.1. Website enrollment

Users were more likely to have enrolled on Mondays and Tuesdays as compared to other days of the week ($p < 0.0001$); enrollment rates did not differ between Mondays and Tuesdays (Fig. 1). The observed proportion of enrollment occurring on Mondays was 8.4% greater (1.2 percentage point increase from a 14.3% base) than the expected proportion if enrollment were evenly distributed throughout the week. Enrollment on Tuesdays was 12.9% greater (1.8 percentage point increase) than the same even weekly distribution. General utilization metrics (number of visits, time on site, number of page views, number of community pages visited, and number of times using the cigarette tracker) did not differ for Monday/Tuesday enrollees vs. later week enrollees.

The day of enrollment distribution differed for daily smokers compared to most/some days smokers ($p < 0.0001$) (Fig. 2). The enrollment pattern of daily smokers mirrors the overall pattern displayed in Fig. 1. The non-daily smokers had a relatively lower enrollment on Tuesdays ($p < 0.0001$) and a higher enrollment on Saturdays ($p < 0.0001$). There was no significant difference in enrollment between the groups on any other day of the week.
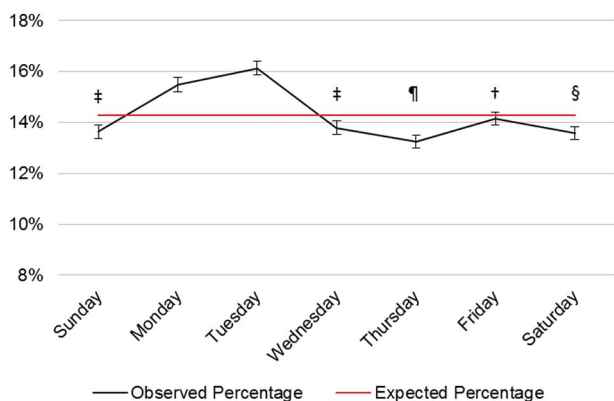
Fig. 1. BecomeAnEX enrollment by day of the week ($n = 69,237$). Significance indicated relative to observed Monday activity: $\dagger p < 10^{-10}$, $\ddagger p < 10^{-15}$, $\S p < 10^{-20}$, $\P p < 10^{-25}$.
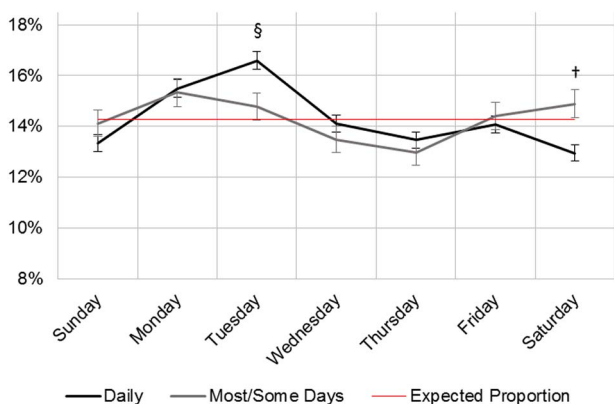

Fig. 2. Day of enrollment by smoking frequency for daily ($n = 42,602$) and non-daily (16,930) smokers. Significant differences: $\dagger p < 10^{-10}$, $\S p < 10^{-20}$.

3.3.2. Quit dates

A total of 5574 current smokers (9.4%) selected a quit date as part of their progress through the EX Quit Plan. There was an overall trend toward selection of quit dates earlier in the week (Sunday–Tuesday) compared to later in the week (Wednesday–Saturday) ($p < 0.0001$); however, Thursdays did not significantly differ from Sundays–Tuesdays for quit date selection (Fig. 3). For initial quit dates, dates that fell on Mondays occurred at a proportion that was 1.7 percentage points greater than expected from an even distribution of 14.3% daily. The higher rate of selection for Sunday, Tuesday and Thursday quit dates did not significantly differ from Mondays.
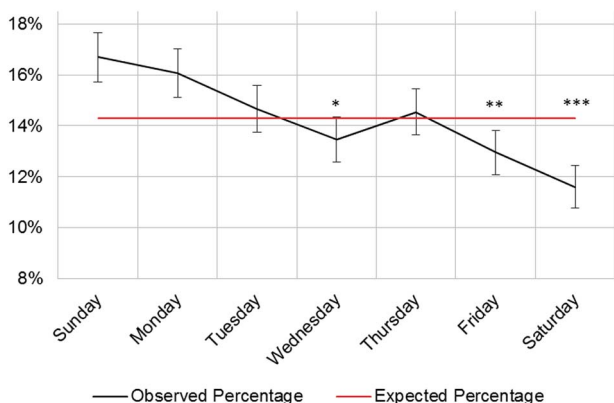

Fig. 3. Initially selected quit day ($n = 5574$). Significance indicated relative to observed Monday activity: $*p < 0.00167$, $**p < 0.0001$, $***p < 10^{-5}$.

Users were able to select a new quit date throughout the program. Of the 5574 users who set quit dates within the first three months of enrollment, 521 (9.3%) of them reselected their quit dates.

Of those who reselected their quit dates, Monday quit dates were most popular (19.6%) and Thursdays were least popular for new quit dates (10.0%). The differences between all days for new quit dates was not significant. There were no significant differences in site activity (number of visits, time on site, number of page views, number of community pages visited, and number of times using the cigarette tracker) for individuals selecting quit dates on different days of the week.

3.3.3. Feature utilization patterns

The day of the week users first visited the site's online community mirrors the weekly pattern found for enrollment. For the users that ever visited the online community, 83% did so on the day they enrolled. There were no significant differences in the proportion of users who visited the community by day of enrollment ($p = 0.022$). Generally, use of site features (email opt in ($p = 0.187$), text messaging opt in ($p = 0.222$), sent a message ($p = 0.222$), read/wrote/comment (on) a blog ($p = 0.448/0.498/0.014$), read tutorial ($p = 0.498$), wall posts ($p = 0.038$)) did not vary by day of enrollment or day on which quit dates fell, but there were exceptions. The likelihood on setting a quit date differed across all days based on day of enrollment ($p < 0.0001$) (Fig. 4). The use of the quit date feature was highest for Wednesday enrollees, with 10.4% setting a quit date and lowest for Saturday enrollees with 7.9% setting a quit date. Use of the quit date feature was comparable among Monday–Thursday enrollees, but lower among Friday–Sunday enrollees compared to Wednesday enrollees (all $p < 0.002$). Use of a feature to track smoking behavior also demonstrated the same pattern, with a higher percentage of Monday–Thursday enrollees using the feature as compared to Friday, Saturday and Sunday enrollees ($p < 0.0001$). Use of a feature to record coping strategies also varied by day of enrollment, with comparable use among Sunday through Thursday enrollees, but lower use among Friday and Saturday enrollees compared to Wednesday enrollees ($p = 0.001$).

4. Discussion

This study found some evidence for an organic weekly pattern of engagement with an online smoking cessation intervention. This pattern was most clearly observed for website enrollment, which was most likely to occur on Mondays and Tuesdays. Quit dates generally tended to occur early in the week, although Thursdays emerged as a popular day as well. It may be that the majority of smokers set a quit date on the
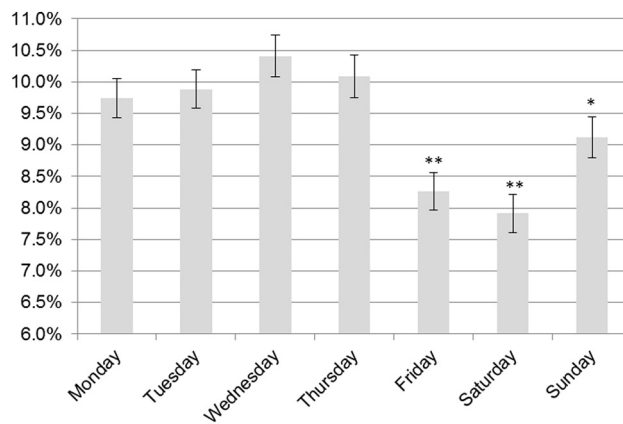

Fig. 4. Percentage setting quit dates by day of enrollment among current smokers ($n = 59,532$). Significance indicated relative to observed Wednesday activity: $*p < 0.01$, $**p < 0.0001$.

day that they register, but some prefer to browse the site and take advantage of the content and tools before committing to a quit date that occurs several days later. Individuals that enrolled on the site Monday through Thursday set quit dates and used the site's main interactive features at higher rates than Friday through Sunday enrollees. These weekly patterns may indicate general fluctuations in smokers' interest in and commitment to smoking cessation behaviors. Results demonstrating higher rates of enrollment at the beginning of the week are consistent with findings from studies of Internet search queries (Ayers et al., 2014a, 2014b; Dai et al., 2014), quitline usage (Erbas et al., 2006), and behavior change initiation (Dai et al., 2014; Orsama et al., 2014).

These findings suggest that Internet smoking cessation interventions could leverage the beginning of the week as a time when larger numbers of smokers are likely to seek out cessation resources to expand their reach through novel marketing and promotion strategies. Advertising content could be tailored to weekly patterns and advertising volume could be distributed strategically throughout the week. Targeted online advertising by day of the week has been used successfully in other industries (Hanafizadeh and Behboudi, 2012) and there is compelling evidence that email open rates across industries are highest early in the week compared to other weekdays (Experian Marketing Service, 2014; Ellering, 2016; Kershner, 2015). Future research should consider the cost effectiveness of increasing media purchases early in the week to take advantage of the increased audience and active information seekers. Likewise, public health campaigns could make an impact further upstream by ensuring that smokers are aware of easily accessible cessation treatment options like Internet interventions at the times when they may be most receptive to such messaging. Our results suggest that the timing of such campaigns may need to be different for daily smokers than for non-daily smokers. The more even distribution of enrollment across days for non-daily smokers could indicate that this group is less intentional about their day of the week enrollment choice. The higher relative enrollment of non-daily smokers on Saturdays is interesting and potentially connected to social smoking behavior, but this dataset cannot differentiate between types of non-daily smokers. This is an important area for future research given that 21.8% of smokers in the US are non-daily users (Centers for Disease Control and Prevention, 2011). Finally, there may be opportunities to increase intervention effectiveness for certain subgroups of users based on day-of-enrollment patterns. It will be important to understand the ways in which feature utilization patterns connect to smoking outcomes and whether the lower rates of feature utilization among later week enrollees signal a risk for poorer outcomes.

Given that this study was observational in nature, we cannot make causal statements about the links between day-of-enrollment patterns and website enrollment or engagement. The results based on quit date selection are based on a much smaller (but still large) sample and should be interpreted accordingly. We applied a 1/6 Bonferroni correction, but some secondary analyses compared multiple outcomes and the correction ratio could have been higher. *p*-Values are provided. This study was also limited by the lack of ability to identify potential mechanisms underlying day-of-the-week patterns. Future research should attempt to determine the drivers of treatment initiation and engagement and how they map to day-of-week fluctuations. As with most web-based interactions, there is some risk of inclusion of malicious users in the dataset that may have altered our findings, but this risk is mitigated by the required email and reCAPTCHA security at registration. Strengths of the study include the large longitudinal dataset in which we were able to explore different types of website engagement. Additionally, data are not self-reported and thus issues of bias and recall are minimized. Our results build on earlier surveillance-focused research and include metrics of both treatment enrollment and engagement from a treatment modality that has not previously been examined (i.e., Internet smoking cessation program).

5. Conclusions

This study builds on previous research suggesting that the beginning of the week is a time when individuals are more likely to seek out and engage with an Internet smoking cessation treatment intervention. These findings have implications for the development of messaging strategies in public health and advertising campaigns, and for potential opportunities to optimize Internet interventions for certain subgroups of users. Leveraging these organic patterns among smokers may serve to increase the public health impact of existing programs and is worthy of future research.

Conflict of interest

SC and ALG are employed by Truth Initiative, which runs the BecomeAnEX website. At the time the study was conducted MJ was employed by the Monday Campaigns, a non-profit public health initiative that dedicates the first day of every week to health.

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