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A randomized controlled evaluation of the tobacco status project, a Facebook intervention for young adults

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ABSTRACT

Aims To test the efficacy of the Tobacco Status Project (TSP) Facebook smoking cessation intervention for young adults relative to referral to an on-line program on biochemically verified 7-day abstinence from smoking. **Design** Two-group parallel randomized controlled trial, comparing TSP (n = 251) to on-line control (n = 249) with follow-up to 12 months. **Setting** On-line, throughout the United States. **Participants** Young adult cigarette smokers (mean age 21 years; 73% white, 55% female, 87% daily smokers). **Interventions and comparator** TSP provided private Facebook groups tailored to stage of change to quit smoking, daily contacts, weekly live counseling sessions, and for those ready to quit, six cognitive behavioral therapy counseling sessions. Some TSP groups were assigned randomly to receive a monetary incentive for engagement. Control provided referral to the National Cancer Institute Smokefree.gov website. **Measurements: primary outcome** Biochemically verified 7-day abstinence over 12 months. **Secondary outcomes** Post-treatment (3-month) abstinence; reported abstinence, quit attempt, reduction in smoking, readiness to quit smoking over 12 months. **Findings** Verified 7-day abstinence was not significantly different for intervention compared with control over 1 year: month 3 (8.3 versus 3.2%), 6 (6.2 versus 6.0%), and 12 (5.9 versus 10.0%); odds ratio (OR) = 1.07; 95% confidence interval (CI) = 0.23, 4.97; retention = 71%. There was an effect at 3 months (OR = 2.52; CI = 1.56, 4.04; $P < 0.0001$). There were no 12-month treatment effects for reported abstinence (P = 0.746), reduction in smoking by 50% or more (P = 0.533), likelihood of having made a quit attempt (P = 0.387) or stage of change over time (0.968). Participants in TSP engaged more and rated the intervention more favorably than those in the control condition. **Conclusions** Compared with referral to a smoking cessation website, a novel USA-focused Facebook smoking cessation intervention did not improve abstinence from smoking over 1 year, but increased abstinence at the end of treatment and was engaging to participants.

Keywords Facebook, randomized trial, smoking cessation, social media, tobacco, young adults.

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INTRODUCTION

Tobacco kills more than 7 million people each year worldwide [1], and young adulthood is the age at which people are most likely to smoke. In the United States, one in four young adults reported past month cigarette use in 2016 [2]. Almost all smokers (98%) report starting before the age of 26 years [3], and more than 2000 US youth and young adults become daily cigarette smokers each day [3,4].

Young adults are just as motivated to quit as other adult age groups, yet are less likely to use evidence-based treatments for smoking cessation (e.g. medication, counseling, quit lines [5–7]. On-line programs offer the potential for expanding the reach of cessation services; however, large drop-offs in engagement have been observed over time [8–13].

Social media have been harnessed to disseminate information widely about a broad range of health concerns, including smoking cessation [14–17]. Facebook, the most

popular social media platform in the United States, is used by 88% of US young adults aged 18–29, 79% of whom access it daily [18], making it promising to deliver public health messaging. Reports of smoking cessation support groups on Facebook have shown the platform to be useful for sharing experiences and providing encouragement and information [19], engaging young adults concerning tobacco prevention [20] and show positive short-term outcomes (e.g. 25% reported 7-day abstinence at 2 weeks in a pilot feasibility study of adults motivated to quit smoking (n = 15) [21]; 47% reported 7-day abstinence at 3 months in a trial including web and social-media components for young adults ready to quit smoking (n = 102) [22]. Research is needed to determine whether a Facebook intervention, without additional supports, is efficacious for both those ready and not ready to quit smoking; whether abstinence can be verified biochemically; and whether abstinence rates can be maintained past 3 months.

Using Facebook, our group developed the Tobacco Status Project (TSP), a motivationally tailored smoking cessation intervention. TSP is a 90-day cessation program combining Facebook posts tailored to participants' readiness to quit smoking with weekly live group counseling sessions. Given the success of monetary incentives in recruiting participants to randomized clinical trials [23] and in yielding short-term abstinence to substance use [24] among previous studies, we additionally randomized participants to receive a monetary incentive tied to engagement in the intervention. An initial feasibility trial with 79 young adults in seven Facebook groups achieved self-reported 7-day abstinence rates of 21% at 6 months (9% of 79 biochemically verified) and 18% at 12 months (9% verified) [25]; 92% of participants remained in a Facebook group for the full 3-month intervention; and 61% (48/79) commented on at least one post, with more commenting among those randomized to receive a monetary incentive (median 16) compared to no incentive (median = 7) [26].

The purpose of this randomized controlled trial was to test the hypothesis that among young adult smokers of cigarettes, the TSP Facebook intervention would result in greater biochemically verified abstinence from smoking relative to a website referral control condition over 12 months. Secondary outcomes included a comparison of biochemically verified point prevalence at the end of treatment (3 months), and reported 7-day abstinence, reduction in cigarettes smoked, whether a quit attempt was made and readiness to quit smoking (proportion in preparation, action or maintenance stage of change) over 12 months. We also examined patterns and correlates of engagement in both groups, and evaluated a monetary incentive for engagement in the TSP intervention as a moderator of engagement and smoking abstinence.

METHODS

Study design

A parallel, two-group, randomized controlled trial with follow-up assessments conducted at 3, 6 and 12 months was used. Details about study design, intervention and control condition, and measures are reported elsewhere [27].

Participants

Participants were recruited over 10 months from October 2014 to July 2015, primarily from Facebook, based on an advertisement campaign developed and used previously by the team [28]. Advertisements included a link to the study's website on Qualtrics [29] with a description of the study and an eligibility survey. Inclusion criteria were English-literate young adults, aged 18–25 years, who reported smoking ≥ 100 cigarettes in their life-times; and at the time of recruitment reported smoking at least one cigarette per day on 3 or more days of the week on average. Intention to quit smoking was not required for trial enrollment; the intervention and control conditions were tailored to stage of change for quitting smoking. Additional inclusion criteria were regular Facebook use (≥ 4 days per week) and access to a digital camera (e.g. on a phone or computer) to send a picture as part of the biochemical validation procedure (see 'Outcome measures' below). Individuals who had participated in the TSP feasibility study were excluded [25]. In total, 500 participants completed a baseline assessment and were randomized to a study condition (Fig. 1).

Study procedure

The UCSF Institutional Review Board approved the study procedures. Informed consent to participate was obtained on-line through the study website. Three multiple-choice questions confirmed understanding of study risks [30]; identity was verified by e-mail or social media; the on-line baseline assessment link was then e-mailed. Following baseline completion, the participants were randomized to TSP (n = 251) or control (n = 249) 1 : 1 using a blocked random assignment sequence generated by the study biostatistician (K.L.D.). The randomization table was held by D.E.R. and the research assistants obtained the group assignment once the baseline assessment was completed. Randomization was stratified by daily smoking status (yes/no) and stage of change for quitting smoking pre-contemplation, contemplation and preparation [31], variables known to be related to outcomes and addressed by the intervention [32]. Within the TSP condition, participants were placed in a Facebook group tailored to stage of change. All groups were assigned randomly 1 : 1 to a monetary incentive condition (daily,

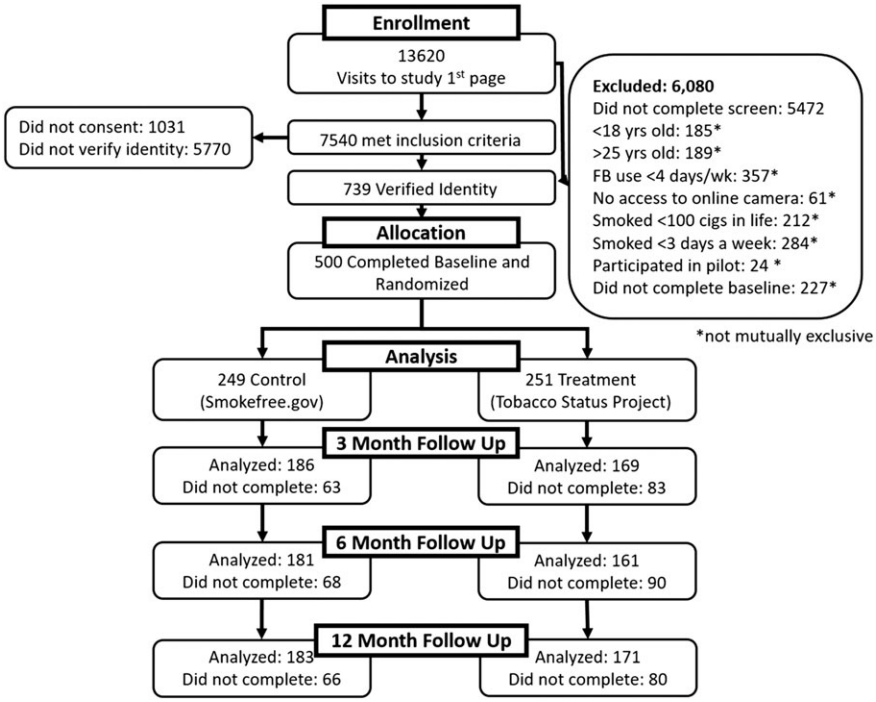

Figure 1 Participants' flow through a Facebook smoking cessation clinical trial

weekly, monthly or no incentive), within stage of change (pre-contemplation, contemplation, preparation), using a scheme generated by the biostatistician and held by the first author. TSP groups began on a rolling basis starting when the first participant had been waiting no longer than 2 weeks; thus, group size varied [26,27]. Twenty-nine Facebook secret groups were created (nine pre-contemplation, 11 contemplation and nine preparation; group size ranged from three to 18). Groups were open for the duration of the trial (12 months), although content was generated by the study team only for the first 3 months.

Immediately after randomization, participants in both conditions were linked by e-mail to the Smokefree.gov website and encouraged to use it actively for the duration of the trial. Assessments were conducted on-line at baseline, 3, 6 and 12 months' follow-up. In both conditions, participants received their choice of gift cards in the amount of $20 per assessment and a $20 bonus for completing all three assessments, for a total possible incentive of $100.

Interventions

Tobacco Status Project (TSP) intervention

The TSP was implemented entirely through 'secret' (i.e. entirely private) Facebook groups. TSP participants were assigned to a Facebook group matched to their baseline stage of change for quitting smoking (pre-contemplation, contemplation, preparation). The group-based intervention had three main features.

First, Facebook posts containing evidence-based smoking cessation strategies were designed to be delivered each day for 90 days via Facebook. Posts were based on the US Clinical Practice Guidelines for smoking cessation [5] and the Transtheoretical Model (TTM) of behavior change [33]. Posts in all groups included a combination of images, videos and text designed to reflect the experience of young adults and elicit a response from participants (see Supporting information, Appendix S1 for a sample of posts in each group).

Secondly, the intervention incorporated weekly 'The Dr Is In' live sessions with a PhD-level smoking cessation counselor, during which the counselor provided some limited content for discussion and participants could ask questions and receive support using Facebook commenting features. Content for sessions was based initially on motivational interviewing, and cognitive behavioral coping skills for smoking cessation were discussed as participants were ready to make a quit attempt.

Thirdly, in the preparation groups, six manualized 45-minute cognitive–behavioral treatment (CBT) sessions over 12 weeks were delivered biweekly through Facebook events (a tool for scheduling live communications on Facebook's newsfeed within private groups). Sessions were adapted for social media delivery from a tobacco treatment manual targeted to adolescents and young adults [34,35] that attended to peer relationships, family influences and the co-use of alcohol and illicit drugs.

Group members could attend the events live, and had access to session content throughout the 90-day intervention period.

Additionally, and only in TSP groups, groups were randomized to one of four incentive conditions tied to engagement in the intervention (daily, weekly, monthly or no incentive). Participants in incentive groups could earn giftcards based on comments made to Facebook posts at the end of the assigned period [$1 (or $0) each day in the daily condition, $7 (or $0) each week in the weekly condition, and $30 (or $0) each month in the monthly condition], up to a maximum of $90 at the end of the 90-day intervention. This was in addition to the $100 incentive that all study participants could earn for completing follow-up assessments. Of the 29 groups, seven were assigned randomly to receive no incentive, six daily, eight weekly and eight monthly incentives.

Control group

Participants received a referral to the National Cancer Institute's Smokefree.gov website. Features include a website tailored to readiness to quit smoking, a texting program, Smartphone application, on-line live chat and a Facebook page. The site includes programs for general adults, women, Spanish-speaking adults and teens. The treatments available to control participants met US Clinical Practice Guidelines for treating nicotine dependence [5].

Measures

Primary outcome measure

The primary outcome was biochemically verified 7-day point prevalence abstinence over 12 months as recommended by the Society for Research on Nicotine and Tobacco Workgroup on abstinence measures [36]. At each follow-up assessment participants reporting 'no smoking, not even a puff' in the past 7 days were coded as abstinent from cigarettes and mailed a NicAlert saliva cotinine test strip with previously established diagnostic accuracy [37] and asked to record two pictures: one giving a saliva sample and another of the test result. Participants with a salivary cotinine level < 11 ng/ml [38] were considered confirmed non-smokers. If participants indicated active use of nicotine replacement therapy (NRT) or an electronic nicotine delivery system (ENDS; e.g. an e-cigarette) to aid in smoking cessation, saliva cotinine confirmed abstinence and reported NRT/ENDS use were recorded and reported separately from biochemically verified abstinence. In analyses, those who reported abstinence from all other tobacco than an e-cigarette to quit smoking and returned saliva cotinine results showing a cotinine range between 11–30 ng/ml were treated as abstinent.

Secondary outcomes

Secondary outcomes included: (1) biochemically verified abstinence at treatment end (3 months); (2) reported 7-day abstinence from cigarettes (including all reports of abstinence not verified biochemically); (3) reduction of cigarette consumption by 50% or more (yes/no) between baseline and each follow-up; (4) presence of at least one 24-hour tobacco quit attempt in the assessment time period (yes/no); and (5) proportion of participants in preparation, action or maintenance stages of change at all time-points [33].

Baseline measures

We assessed participants' age, gender, race/ethnicity, completed education, annual income, housing stability, employment, marital status and smoking history [39]. Additional measures included the Fagerström Test of Cigarette Dependence (FTCD) [40]; a three-item Social Smoking measure used previously with young adults [41]; and the Thoughts about Abstinence scale (desire, success and difficulty, rated on 10-point scales and goal-related to smoking coded as 0 = no goal, 1 = intermediate goal or 2 = quitting for good) [42].

Treatment acceptability/engagement

An eight-item measure, used in our prior work [25], was administered at intervention end (3 months) to assess whether the intervention components in each condition were accessed and general reactions (e.g. 'The [intervention] was helpful'). The items were reported on a four-point scale from 'strongly disagree' to 'strongly agree'. Proportions of those reporting 'agree' or 'strongly agree' were computed for each item. In addition, for TSP, participant comments were tallied across all intervention content (study-generated posts, user-generated posts, live sessions and CBT sessions) during the 3-month intervention period (comment volume).

Data analyses

To examine abstinence versus smoking status at the 3–12-month follow-ups by condition (the primary hypothesis), we estimated and tested a logistic regression model using a mixed-effects model (via PROC GLIMMIX in SAS version 9.4; SAS Institute, Cary, NC, USA). The model accounted for dependence of responses within individuals attributable to repeated measures and, clustering effects due to treatment group membership, for dependence of responses within Facebook groups, and allowed us to derive effect estimates from all available data. Analysis was conducted first using all available data included in the modeling and participants assigned to the treatment condition to which they were randomized. We chose this strategy because it

Table 1 Participant characteristics (n = 500).

Variable	*Full sample (n = 500)*	*Treatment (n = 251)*	*Control (n = 249)*
Age (mean/SD)	20.9 (2.0)	20.9 (2.0)	20.9 (2.0)
Sex (%/*n*)			
Male	44.8 (224)	44.2	45.4
Female	54.6 (273)	55.0	54.2
Sexual minority	0.6 (3)	0.8	0.4
Race or ethnicity[a] (%/*n*)			
Non-Hispanic Caucasian	73.8 (366)	77.0	70.6
Native American	1 (5)	1.2	0.0
African American	2.6 (13)	3.6	1.6
Asian/Pacific Islander	1.2 (6)	1.2	1.2
Hispanic	6.9 (34)	5.2	8.5
More than one	14.5 (72)	11.7	17.3
Employment status (%/*n*)			
Employed, part-time	19.8 (99)	18.3	21.3
Employed, full-time	43.4 (108)	46.6	40.2
Unemployed, looking	30.6 (153)	29.1	32.1
Unemployed, not looking	6.2 (31)	6.0	6.4
Education (%/*n*)			
High school degree or less	48.0 (240)	46.3	49.8
Some college	46.2 (231)	46.6	45.8
College degree or higher	5.8 (29)	7.3	4.4
Education status (%/*n*)			
Not in school	69.6 (348)	67.3	71.9
Part-time	8.8 (44)	10.0	7.6
Full-time	21.6 (108)	22.7	20.5
Household income (%/*n*)			
Less than $20 000	28.8 (144)	29.5	28.1
$21 000–60 000	49.0 (245)	51.4	46.6
$61 000–100 000	15.4 (77)	16.5	14.3
More than $100 000	6.8 (34)	8.8	4.8
Geographic region (%/*n*)[b]			
South	32.4 (161)	36.4	28.3
Midwest	29.2 (149)	28.4	30.4
Northeast	15.4 (77)	11.6	19.4
West	22.7 (113)	23.6	21.9
Cigarettes per day (%/*n*)			
10 or fewer	48.0 (240)	50.2	45.8
11–20	46.6 (233)	43.4	49.8
21–30	4.0 (20)	5.2	2.8
31 or more	1.4 (7)	1.2	1.6
Cigarettes per day (mean/SD)	11.6 (6.8)	10.8 (6.3)	11.4 (7.2)
Days per week smoked (mean/SD)	6.8 (.86)	6.7 (0.9)	6.7 (0.9)
Stage of change at baseline (%/*n*)			
Pre-contemplation	30.0 (150)	29.9	30.1
Contemplation	48.6 (243)	47.4	49.8
Preparation	21.4 (107)	22.7	20.1
Past year 24-hour quit attempt (% yes/SD)	62.2 (311)	62.5	61.8
FTCD (mean/SD)	3.2 (2.1)	3.2 (2.1)	3.1 (2.1)
Smoke within first 30 minutes of waking (% yes/*n*)	53.2 (266)	53.8	52.6
Daily smoking (% yes/*n*)	86.6% (433)	87.3	85.9
Social smoker (% yes/*n*)	71.2 (356)	73.3	69.1
Desire to quit (range: 0–9)	5.6 (2.9)	5.5 (2.9)	5.7 (2.8)
Perceived quit success (range: 0–9)	4.8 (2.6)	4.8 (2.6)	4.8 (2.6)
Perceived quit difficulty (range: 0–9)	7.5 (2.4)	7.5 (2.5)	7.5 (2.3)
Sustained abstinence goal (% yes)	11.4% (205)	12.0	10.8

FTCD = Fagerström Test of Cigarette Dependence; SD = standard deviation. [a]n = 496; [b]n = 497.

is consistent with current statistical practice [43,44], concerns put forth by a Society for Research on Nicotine and Tobacco task force on analysis in clinical trials [45], and published trials from our group [39,46]. The independent variables were TSP versus control condition and time, plus variables that are known to be related to successful quitting (daily smoking status and stage of change at baseline). The outcome variable was verified abstinence, treating reported ENDS or NRT use for cessation as abstinent as long as no other nicotine or tobacco product was used. The study was powered to detect differences of approximately 5% in rates of use [27]. Follow-up logistic regression analyses compared abstinence at treatment end (3 months) between treatment and control groups, with the same covariates as the primary analysis. Reported abstinence, 50% reduction in cigarettes/week and making a 24-hour quit attempt were modeled similarly. To be consistent with some of the literature, the analysis of the primary outcome was repeated after imputing all missing data as positive for smoking (i.e. intent-to-treat).

Kruskal–Wallis tests were used to compare comment volume by stage of change and incentive condition. Bivariate models predicted whether demographic and smoking variables predicted comment volume. Two analyses tested the effects of comment volume (Wilcoxon's signed rank) and incentive (Person's χ^2) on 3-month abstinence. Outcome variables were biochemically verified abstinence and self-reported abstinence.

RESULTS

Retention

Participant characteristics are in Table 1. Follow-up completion was 71.0% (355 of 500) at 3 months, 68.4% (342 of 500) at 6 months and 70.8% (354 of 500) at 12 months with no difference in number of follow-up assessments completed between treatment and control ($\chi^2 = 3.64$, $P = 0.302$), baseline readiness to quit smoking ($\chi^2 = 6.673$, $P = 0.352$), daily smoking status ($\chi^2 = 1.231$, $P = 0.746$) nor, among those in the TSP condition ($n = 251$), assignment to a group with a monetary incentive ($\chi^2 = 5.69$, $P = 0.770$). Forty participants (16%) left their Facebook group at some point during the 3-month intervention period, with dropout greatest among those in pre-contemplation (24%) compared to contemplation (10%) or preparation (18%; $\chi^2 = 6.79$, $P = 0.033$).

Primary outcome: biochemically verified 7-day abstinence

Smoking status throughout 12 months is reported in Table 2. We obtained saliva cotinine test results on approximately half of participants self-reporting abstinence at 3 months (22 of 36; 61%), 6 months (24 of 50; 48%) and 12 months (34 of 69; 49%), with no difference in receipt of cotinine test results by treatment condition. In analyses using available data, and considering those who reported using only ENDS as abstinent from cigarettes, we modeled the abstinence rates over 12 months and found no significant difference by treatment condition [(month 3 [8.3% vs. 3.2%]), 6 [6.2% vs. 6.0%], and 12 [5.9% vs. 10.0%]; odds ratio (OR) = 1.07; 95% confidence interval (CI) = 0.23, 4.97; $P = 0.924$; Table 3]. Re-analysis with missing data coded as smoking produced similar results (OR = 1.0; CI = 0.24, 4.46; $P = 0.969$). Five participants reported sustained abstinence throughout 12 months (two treatment; three control).

Secondary outcomes

Comparisons between treatment and control at treatment end (3 months), controlling for baseline stage of change and daily smoking status, found a significant difference between treatment and control (OR = 2.52; CI = 1.56, 4.04; $P < 0.0001$). Findings were similar with missing = smoking (OR = 2.71 (CI = 1.02–7.22; $P = 0.039$). Readiness to quit and daily smoking at baseline predicted abstinence over the 12 months, with daily smokers and those in preparation more likely to be abstinent over time than those in pre-contemplation (Table 3).

Self-reported 7-day point prevalence abstinence was 13.6% (23 of 169) for treatment and 7.5% (14 of 186) for control participants at the 3-month follow-up, 18.6% (29 of 156) and 14.5% (25 of 172) at 6 months and 21.8% (37 of 170) and 20.8% (38 of 183) at 12 months, respectively, with OR = 1.29; 95% CI = 0.26, 6.36; $P = 0.746$ for the overall model; Table 3. Abstinence increased over 1 year in both groups, with the largest absolute difference between groups at 3 months (6.1%). There were no significant treatment effects over 12 months for reduction in cigarettes smoked, quit attempts or likelihood of being ready to quit or quit (Table 3).

Treatment engagement

Participants in both groups rated the extent to which study treatment materials were engaging and useful (Fig. 2). TSP participants gave significantly higher ratings on all measures compared to the control condition (all $P < 0.001$). Highest ratings were for ease of understanding the intervention (96%), thinking about what they read (92%) and believing the material gave sound advice (91%).

Among TSP participants, 77% ($n = 192$) commented at least once to their Facebook group. Median commenting among the full TSP sample was 13 [interquartile range (IQR) = 1–66], and among those who commented at least once was 31 (IQR = 7–84); 101 participants (40.6%) commented at least once during a live counseling session. Ten (15.9% of participants in preparation) participated in

Table 2 Smoking cessation outcomes among young adults in the Tobacco Status Project intervention (treatment) versus referral to Smokefree.gov (control) over 12 months (n = 500).

	3 months						*6 months*						*12 months*					
	Treatment			*Control*			*Treatment*			*Control*			*Treatment*			*Control*		
	n	% *available data*[b]	% *missing = smoking*[b]	*n*	% *available data*	% *missing = smoking*	*n*	% *available data*	% *missing = smoking*	*n*	% *available data*	% *missing = smoking*	*n*	% *available data*	% *missing = smoking*	*n*	% *available data*	% *missing = smoking*
Reported abstinence, verified	12	**7.1**	**4.8**	5	**2.7**	**2.0**	9	**5.6**	**3.6**	9	**4.9**	**3.6**	11	**5.9**	**4.4**	14	**8.2**	**5.6**
Reported used ENDS	2	**1.2**	**0.8**	1	**0.5**	**0.4**	1	**0.6**	**0.4**	2	**1.1**	**0.8**	0	**0**	**–**	3	**1.8**	**1.2**
Reported abstinence not verified	9	**5.3**	**3.6**	8	**4.3**	**3.2**	15	**9.3**	**6.0**	18	**9.9**	**7.2**	26	**14.1**	**10.4**	21	**12.4**	**8.4**
Reported smoking	145	**86.3**	**57.8**	172	**92.5**	**69.1**	136	**84.5**	**54.6**	152	**84.0**	**60.6**	148	**80.0**	**60.0**	132	**77.6**	**53.0**
No response	83	**–**	**33.1**	63	**–**	**25.3**	90		**35.3**	68	**–**	**27.9**	66		**26.3**	79		**31.7**
Total[a]	251	**99.9**	**100.0**	249	**100.0**	**100.0**	251	**100.0**	**100.0**	249	**99.9**	**100.1**	251	**100.0**	**100.0**	249	**100.0**	**100.0**

ENDS = electronic nicotine delivery system. [a]Total percentage of values may not add up to 100 due to rounding; [b]In primary outcome analyses reported abstinence, verified and reported used ENDS values were pooled.

Table 3 Mixed effects regression models testing the effect of intervention (Tobacco Status Project versus Smokefree.gov) on biochemically verified abstinence, reported abstinence, reduction in smoking, likelihood of making a quit attempt and readiness to quit over 12 months (n = 500).

	Biochemically verified abstinence (% yes)			*Reported abstinence (% yes*			*Reduction in smoking by 50% or more (% yes)*			*Quit attempt (% yes)*			*Ready to quit or quit (% in preparation, action or maintenance)*		
	OR	*95% CI*	*P*	*OR*	*95% CI*	*P*	*OR*	*95% CI*	*P*	*OR*	*95% CI*	*P*	*OR*	*95% CI*	*P*
Treatment (versus control)	1.07	0.23–4.97	0.925	1.29	0.26–6.36	0.746	1.43	0.45–4.54	.533	0.94	0.23–3.78	0.929	0.927	0.089–9.68	0.947
Daily smoking status (versus non-daily)	2.31	1.21–4.41	0.015			0.001	0.16	1.06–2.43	0.027	0.53	.348–.804	00.005	0.50	0.349–0.731	0.001
Baseline stage of change															
Preparation (versus pre-contemplation)	0.21	0.05–0.83	0.036	0.16	0.05–0.45	0.011	0.29	0.15–0.57	0.010	5.86	2.87–11.96	0.004			
Contemplation (versus pre-contemplation)	0.42	0.11–1.64	0.136	0.28	0.10–0.78	0.029	0.51	0.29–0.90	0.032	3.57	2.02–6.32	0.006			

CI = confidence interval; OR = odds ratio.

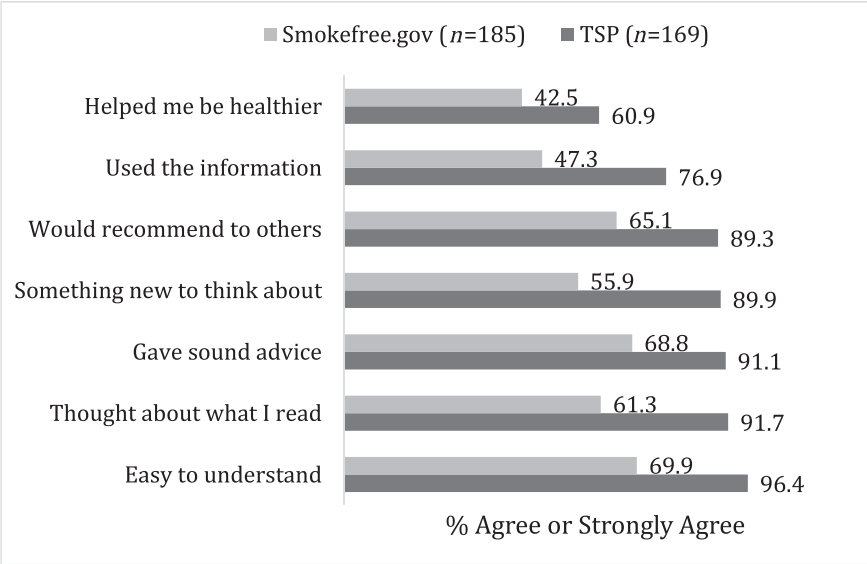

Figure 2 Proportion of 'agree' or 'strongly agree' reports about content in the Tobacco Status Project (TSP) intervention versus control condition (Smokefree.gov); $n = 355$. All comparisons were significant with $P < 0.001$

one or more CBT treatment sessions during the 90-day intervention period. Stage of change ($\chi^2 = 6.96$, $P = 0.031$) and incentive condition ($\chi^2 = 17.64$, $P = 0.001$) was related to comment volume. Comments were greater among those in pre-contemplation (median = 22; IQR = 3–82) and preparation (median = 23; IQR = 2–70) than contemplation (median = 7; IQR = 0–57). Groups with an incentive had higher comment volume than no-incentive, and monthly and weekly incentives had the highest volumes (none: median = 5; IQR = 0–25; monthly: median = 30; IQR: 2–87; weekly: median = 31; IQR: 2–94; daily: median = 11; IQR = 1–50). Incentives were related significantly to comment volume in contemplation ($\chi^2 = 14.59$, $P = 0.002$) and preparation ($\chi^2 = 9.95$, $P = 0.019$), but not pre-contemplation ($\chi^2 = 6.80$, $P = 0.079$).

No other individual predictors of comment volume (demographics, smoking characteristics) were significant in bivariate models. Comment volume did not relate significantly to either verified abstinence (abstinent: median = 62; non-abstinent: median = 45; Wilcoxon's $Z = 1.22$, $P = 0.224$) or reported abstinence at 3 months (abstinent: median = 60; non-abstinent: median = 45; Wilcoxon's $Z = 1.26$, $P = 0.208$). Incentive condition was not associated with either verified ($\chi^2 = 3.29$, $P = 0.349$) or reported abstinence ($\chi^2 = 1.21$, $P = 0.750$) at 3 months.

Among control participants, 30.8% ($n = 57$) reported ever use of Smokefree.gov services (29.2% Smokefree.gov, 6.5% SmokefreeWomen, 3.8% SmokefreeTeen; 0% Smokefree en Español). Use of any Smokefree.gov tools did not relate significantly to either verified ($\chi^2 = 1.02$, $P = 0.312$) or reported abstinence ($\chi^2 = 2.49$, $P = 0.114$) at 3 months.

DISCUSSION

The TSP Facebook quit smoking intervention did not reduce significantly the odds of a biochemically verified quit over 12 months when compared to an evidence-based website. However, this study, the first to report use of Facebook as a smoking cessation intervention, resulted in a high level of engagement, a good level of active participation and limited dropout. In secondary analyses, end-of-treatment differences were found between TSP and the control condition on 3-month biochemically verified abstinence. The lack of differences over 1 year may reflect as much the relatively low compliance to biochemical verification procedures as actual lack of differences between conditions; certainly, compliance needs to be increased if biochemically verification is to be used as the gold standard in internet-based studies. The loss of differences in abstinence to 12 months also suggests the potential value of extending the intervention duration. The intervention did not result in differences in reported abstinence, reduction in smoking, likelihood of a quit attempt or readiness to quit smoking over 12 months. The null findings to 1-year follow-up may be due to the relatively short duration of the 3-month intervention and the inclusion of young adult smokers not ready to quit. Interventions aimed at engaging and treating smokers not prepared to quit have typically extended intervention contacts to 12 months with an 18-month follow-up, and have demonstrated increases in abstinence over time [46,47].

TSP was engaging for young adults, with limited dropout, and generally solicited active participation comparable to or greater than other social media intervention

programs [22,48,49], especially given that only one-quarter of the TSP group indicated a desire to quit at intervention start. In the control condition, our quit rates were similar to those found in other clinical trials with referral to Smokfree.gov as a condition (e.g. 6.8% [50] and 10% [51] reported abstinence among motivated adults after 3 months).

In both treatment conditions, as expected, abstinence over time was more likely among those in preparation compared to contemplation or pre-contemplation. Within the TSP condition, despite not being ready to quit, those in pre-contemplation commented as frequently as those ready in the next month (preparation). This suggests that the social media environment can be an engaging tobacco treatment tool for those not ready to quit. Those not ready to quit may have participated in the trial solely for incentives, yet the engagement in these groups suggests that a longer intervention could aid this group in moving toward abstinence. In our feasibility trial, content related to decisional balance (increasing the pros and decreasing the cons of change) was most engaging in both pre-contemplation and contemplation groups [52], and its prominence in the pre-contemplation groups was probably also engaging in the clinical trial. Those in contemplation, however, were less engaged, suggesting that the content may not have been as well designed as in the other two groups. Indeed, commenting was also less frequent in contemplation groups than other groups in the feasibility trial [25]; while changes were made, additional changes may be needed to engage those in contemplation in a future delivery of the TSP. A more detailed examination of engagement by content type and group factors (e.g. size) is warranted.

The effectiveness of a monetary incentive at increasing engagement in the TSP group shows that, for widespread dissemination, monetary incentives may be needed to maximize participation, especially for those ready to quit during the next 6 months. Cost-effectiveness analysis is warranted and planned for the future. Although engagement in TSP was unrelated to abstinence in this study, this is probably due in part to low power to detect an effect given a relatively low abstinence rate.

Three intervention strategies were used with varying success. A high proportion of engagement with daily posting and 'The Dr Is In' live sessions (77% commented at least once) suggest that content delivered 'publicly' within groups was effective at engaging users. While it is impossible to discern from a wholly digital study whether viewing a post was associated with behavior change, and we used a proxy of commenting to measure engagement, it is likely that many more users who did not comment still engaged in some way with the intervention and may have changed their thoughts and/or behaviors as a result. Additional research should evaluate whether engagement varied by content or design features of postings or individual characteristics of participants. CBT sessions implemented in 'events' within the Facebook groups were less engaging. CBT sessions that were implemented using Facebook's private messaging feature in the feasibility trial of TSP [25] were moved to a more public format within the private Facebook groups for this trial to maximize reach within groups. Unfortunately, engagement in the organized events for these sessions still remained low (16% of those in preparation commented at least once), suggesting that live sessions within groups were a better use of counselor time. 'The Dr Is In' sessions were more effective, and may be the only strategy needed for live sessions in future intervention delivery.

Our study sample was similar to the US population of smokers, with almost half men and almost three-quarters non-Hispanic white. Our study recruited 45% males, more than other on-line smoking cessation trials, which tend to have a majority of women [53,54]. Social media, or at least Facebook, may be particularly useful for engaging young men in tobacco treatment. Our intervention was designed to appeal to the general audience of young adult smokers and it is unknown whether it would be as engaging to vulnerable smokers [e.g. mental health populations, lesbian, gay, bisexual, transgender, questioning, queer (LGBTQ)+-identified young adults]. Trials evaluating the efficacy of the TSP to tailored interventions for special populations are under way (ClinicalTrials.gov: NCT03163303, NCT03259360). Although nicotine replacement is recommended by the clinical practice guidelines for smoking cessation [5], the large proportion of participants smoking fewer than 10 cigarettes per day suggested that nicotine replacement would not be indicated for most participants. We did not provide nicotine replacement in this study, and no participant reported using nicotine replacement in a cessation attempt during the trial, despite a majority of participants reporting at least one quit attempt at each time-point. In contrast, ENDS use, common among young adults [55], was reported as a quit strategy. The pros and cons of using ENDS for cessation should be addressed in smoking cessation interventions with young adults. Overall quit rates in the trial were fairly low; provision of nicotine replacement as an adjunct to the on-line treatment may help to improve these rates in future studies, albeit with a threat to external validity given its lack of dissemination in the real world.

Limitations include that some groups in the TSP condition (rather than control) received a monetary incentive for engagement. There is some debate as to the utility of the Transtheoretical Model as a predictor of smoking cessation [56], yet many studies have found it to lead to short- and long-term smoking cessation [57–65].

CONCLUSIONS

The social media intervention had a significant effect on abstinence while the intervention was active. Once removed, the treatment effects were not sustained in follow-up assessments to 1 year. The intervention modality and channel appears effective in reaching and engaging young adult smokers, which has been a challenging group to treat. Future work should examine feasible strategies for sustaining the effects, perhaps with more extended interventions, given the chronicity of tobacco addiction and the major health harms accumulated with continued smoking.

Trial registration number

NCT02207036.

Declaration of interests

D.R. has consulted to Carrot Inc., which makes a tobacco cessation device. S.H. has consulted to Carrot Inc. and Biorealm; J.J.P. has consulted to Pfizer, which makes smoking cessation medications; is an advisor to Carrot Inc.; and has been an expert witness for plaintiffs' counsel in court cases against the tobacco companies. All other authors declare no completing interests.

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Supporting Information

Additional Supporting Information may be found online in the supporting information tab for this article.

Appendix Sample Tobacco Status Project posts tailored to readiness to quit smoking according to Transtheoretical Model processes of change and posts for all levels of readiness based on motivational interviewing and electronic cigarette content.