Short Communication

Get with the program: Adherence to a smartphone app for smoking cessation

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HIGHLIGHTS

• Study identified empirically and theoretically-informed measures of engagement in a smoking cessation app.
• Fully adherent users (24%) to the smoking cessation app program were over four times more likely to quit smoking.
• Lower acceptance of cravings to smoke was a predictor of full adherence to the app program.
• Research is needed on methods to promote engagement with app components predictive of desired smoking cessation outcomes.

ARTICLE INFO

ABSTRACT

Introduction: Although engagement is generally predictive of positive outcomes in technology-based behavioral change interventions, engagement measures remain largely atheoretical and lack treatment-specificity. This study examines the extent to which adherence measures based on the underlying behavioral change theory of an Acceptance and Commitment Therapy (ACT) app for smoking cessation predict smoking outcomes, and user characteristics associated with adherence.
Methods: Study sample was adult daily smokers in a single arm pilot study (n = 84). Using the app's log file data, we examined measures of adherence to four key components of the ACT behavior change model as predictors of smoking cessation and reduction. We also examined baseline user characteristics associated with adherence measures that predict smoking cessation.
Results: Fully adherent users (24%) were over four times more likely to quit smoking (OR = 4.45; 95% CI = 1.13, 17.45; $p = 0.032$). Both an increase in tracking the number of urges passed (OR = 1.02; 95% CI = 1.00, 1.03; $p = 0.043$) and ACT modules completed (OR = 1.27; 95% CI = 1.01, 1.60; $p = 0.042$) predicted cessation. Lower baseline acceptance of cravings was associated with over four times higher odds of full adherence (OR = 4.59; 95% CI = 1.35, 15.54; $p = 0.014$).
Conclusions: Full adherence and use of specific ACT theory-based components of the app predicted quitting. Consistent with ACT theory, users with low acceptance were most likely to adhere to the app. Further research is needed on ways to promote app engagement.

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1. Introduction

Smoking remains an undertreated public health problem worldwide, accounting for six million deaths and an economic burden of half a trillion dollars annually (World Health Organization, 2013). Smartphone applications could play an integral role in reducing the personal and societal costs of smoking due to their high population reach (Dediu, 2013; Statistica, 2015) and immediate accessibility. Apps, like other technology-based platforms for delivering behavioral interventions, are plagued by the problem of attrition (Eysenbach, 2005)—this includes low utilization of apps for weight loss (Guertler, Vandelanotte, Kirwan, & Duncan, 2015; Carter, Burley, Nykjaer, & Cade, 2013; Duncan et al., 2014), PTSD (Owen et al., 2015), and smoking cessation (Ubhi, Michie, Kotz, Wong, & West, 2015). This limits potential for behavioral change because engagement is generally predictive of positive outcomes (Seidman et al., 2010; Strecher et al., 2008; Muñoz et al., 2009; Richardson et al., 2013; An, 2008; Lenert et al., 2002; Cobb, Graham, Bock, Papandonatos, & Abrams, 2005; Graham, Cobb, Raymond, Sill, & Young, 2007), although there have been some

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mixed findings in this regard (Muñoz et al., 2009; Graham et al., 2007; Donkin et al., 2011). These mixed findings may be attributable to the state of the literature on engagement with electronic health (eHealth) interventions, in which engagement is broadly defined and largely atheoretical, encompassing frequency, length, and depth of use. Empirically-based engagement metrics guided by the theory of behavior change underlying the intervention might better inform what users need to do in order for the intervention to be effective.

Another engagement-related application of behavioral theory is to examine which types of users engage with the theoretically-consistent components of a behavioral intervention. Doing so might inform whom to target to increase engagement with these key ingredients. While studies have looked at how user characteristics predict utilization in web (Strecher et al., 2008; Cobb et al., 2005; Balmford, Borland, & Benda, 2008; Feil, Noell, Lichtenstein, Boles, & McKay, 2003; Patten et al., 2007; Wangberg, Bergmo, & Johnsen, 2008; Japuntich et al., 2006; Zbikowski, Hapgood, Smucker Barnwell, & McAfee, 2008) and app-based (Zeng, Vilardaga, Heffner, Mull, & Bricker, 2015) smoking cessation interventions, none have examined theory-based psychological change targets as predictors. In Acceptance and Commitment Therapy (ACT) theory, a key psychological change target is experiential acceptance, defined as a willingness to allow aversive internal states (e.g., anxiety or physical discomfort) to be present without smoking as a means of reducing them. ACT also helps people identify what is important to them in life (i.e., their values) and commit to behaviors in line with their values. Based on the theory, those who stand to benefit most from the intervention are those with low acceptance. Indeed, evidence different modalities of treatment delivery (i.e., phone and app-based interventions) indicates that those with low baseline acceptance benefit most from ACT (Bricker, Bush, Zbikowski, Mercer, & Heffner, 2014a; Bricker et al., 2014b). In addition, an increase in acceptance of smoking-related thoughts, feelings, and sensations mediates quit outcomes in ACT-based smoking cessation studies (Bricker et al., 2014a; Bricker et al., 2014b; Bricker, Wyszynski, Comstock, & Heffner, 2013; Gifford et al., 2004; Schuck, Otten, Kleinjan, Bricker, & Engels, 2014).

In this study, we tested whether theory-based engagement metrics predict behavioral change outcome in the context of an ACT-based cessation app that contains evidence-based features (Heffner, Vilardaga, Mercer, Kientz, & Bricker, 2014). To inform which user characteristics predict key indices of engagement, we examined the role of acceptance in addition to variables that have previously been found to predict general utilization in web (Strecher et al., 2008; Cobb et al., 2005; Balmford et al., 2008; Feil et al., 2003; Patten et al., 2007; Wangberg et al., 2008; Japuntich et al., 2006; Zbikowski et al., 2008) and app-based (Zeng et al., 2015) cessation studies. Although it is not possible to detect the directionality of the relationship between adherence and smoking outcomes, results from this study will inform development of cessation apps by identifying which specific app features might optimize cessation outcomes and which types of users engage with these features.

2. Methods

2.1. Participants

In this secondary analysis, we examined app usage data from 84 adult daily smokers in a single-arm pilot study who provided two-month follow-up data. The eligibility criteria for the pilot study were: (World Health Organization, 2013) age 18 or older, (Dediu, 2013) smokes at least five cigarettes daily for at least the past year, (Statistica, 2015) wants to quit smoking in the next 30 days, (Eysenbach, 2005) has daily access to a smartphone, which was either an iPhone IOS Version 6 or higher or Android Version 4.1 or higher and (Guertler et al., 2015) not participating in any other cessation interventions. See Table 1 for descriptive statistics of the study sample.

2.2. Recruitment

Potential participants were recruited through their employers (n = 150) or through Facebook advertisements (n = 293) and were emailed a link to the recruitment website. Participants who screened eligible (n = 347), completed consent (n = 221), filled out baseline measures (n = 201), and provided their email address twice for confirmation (n = 161), were e-mailed a secured link and passcode to download the app (n = 99 downloaded). Afterwards, participants were sent e-mail reminders to open the app.

2.3. Data collection

Participants who completed the consent form were administered an online baseline survey that assessed demographic and smoking characteristics. At 2-month post-randomization follow-up, participants were administered a survey assessing their quit outcomes. Consistent with complete case analytic methods, only those (n = 84) who responded to questions about their smoking status in the outcome survey (85% retention) are included in these analyses.

2.4. App description

Upon initial app access, users were prompted to complete a quit plan, including picking a quit date. From the home screen, users complete one ACT exercise each day for the first 8 days of use in addition to tracking smoking urges and letting urges pass. After these activities are completed, other features of the app are unlocked in the "Anytime Coaching" section, which includes ACT-based exercises to support quitting (e.g., how to deal with lapses, motivation for quitting, inspirational stories of past quitters). Informed by results from a prior study of the features of our app that predict smoking cessation (Heffner et al., 2014), we defined the requirements to earn a Certificate of Completion as the completion of four app components: (World Health Organization, 2013) creating a quit plan, (Dediu, 2013) completing 8 daily ACT modules, (Statistica, 2015) tracking letting 10 urges pass, and (Eysenbach, 2005) visiting the Anytime Coaching section at least once (see screenshots of each component in Supplementary materials). The ACT exercises focus on building and maintaining motivation by connecting with values guiding quitting, handling urges through development of acceptance skills (e.g., mindfulness, obtaining psychological distance from thoughts that trigger smoking), and handling lapses by practicing self-compassion. Heffner et al. (2014) provides more information on the ACT exercises in the app.

2.5. Measurements

2.5.1. Adherence measures

We extracted and analyzed log file data to assess adherence across the first two months of usage, as this was the pre-established period of evaluation. We measured full adherence as whether or not the user completed all of the four program components required for a Certificate of Completion (listed above), partial adherence as the number (out of

Table 1
User characteristics of participants from a single-arm smoking cessation app study (n = 99).

Demographics	Value
Age, mean (SD)	38.4 (8.9)
Male, n (%)	22 (22.2)
White	96 (97.0)
HS or less education, n (%)	25 (25.3)
Smokes more than half a pack (>10 cigs) a day, n (%)	82 (82.8)
Smoked 10 years or more, n (%)	80 (80.8)
Working, n (%)	69 (69.7)
Living with partner who smokes n (%)	24 (24.2)