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## Identifying attendance patterns in a smoking cessation treatment and their relationships with quit success\*

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### Abstract

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**Background**—While important for substance use outcomes, knowledge about treatment attendance patterns, and their relation with clinical outcomes is limited. We examined the association between attendance patterns and smoking outcomes in a randomized, controlled smoking cessation intervention trial.

**Methods**—In addition to standard smoking cessation treatment, participants were randomized to 15 weeks of an exercise intervention (n=72) or an education control condition (n=64). Latent class growth analysis (LCGA) tested whether intervention attendance would be better modeled as qualitatively distinct attendance patterns rather than as a single mean pattern. Multivariate generalized linear mixed modeling (GLMM) was used to evaluate associations between the attendance patterns and abstinence at the end of treatment and at 6-month follow-up.

**Results**—The LCGA solution with three patterns characterized by high probability of attendance throughout (Completers, 46.3%), gradual decreasing probability of attendance (Titrators, 23.5%), and high probability of dropout within the first few weeks (Droppers, 30.1%) provided the best fit. The GLMM analysis indicated an interaction of attendance pattern by treatment condition, such that titration was associated with lower probability of quit success for those in the control condition. Probability of quit success was not significantly different between Titrators and Completers in the exercise condition.

**Conclusions**—These findings underscore the importance of examining how treatment efficacy may vary as a function of attendance patterns. Importantly, treatment discontinuation is not necessarily indicative of poorer abstinence outcome.

## Keywords

attendance; dropout; dose-response; exercise; smoking cessation; anxiety sensitivity

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## 1. INTRODUCTION

Despite a reduction in smoking prevalence, there remain one billion cigarette smokers worldwide, over 40 million of whom live in the United States (Centers for Disease Control and Prevention [CDC], 2011). Over 50% of U.S. smokers attempt to quit annually, yet only 6% succeed (CDC, 2015, 2011). Although effective treatments exist, completion rates reported in smoking cessation trials range from 50%–70% (Baker et al., 2006; Borrelli et al., 2002; Curtin et al., 2000; Evins et al., 2008; Marcus et al., 1999). In some cases, a greater number of sessions attended or treatment completion have shown positive associations with outcomes (Baker et al., 2006; Fiore, 2008; Smits et al., 2016; Whiteley et al., 2012), but this is not ubiquitous, suggesting individual differences in dose-response exist (Baldwin et al., 2009; Barkham et al., 2006; Owen et al., 2016; Reese et al., 2011). The Good Enough Level (GEL) model posits that optimal treatment dosage varies as a function of individual improvement rates such that patients who improve quickly may self-modulate treatment dosage via early discontinuation (Owen et al., 2016; Reese et al., 2011).

Evidence consistent with the GEL model has been reported in the substance use disorder literature. For example, in a clinical trial of prolonged exposure with naltrexone for comorbid posttraumatic stress disorder (PTSD) and alcohol dependence, both fast and slow rates of PTSD symptom improvement, as well as fast rates of drinking improvement, were

each associated with early dropout (Zandberg et al., 2016). Another treatment trial for comorbid PTSD and SUD used a person-centered approach to empirically derive distinct attendance patterns of early dropout, titration, and completion—importantly; treatment titration was not associated with poorer outcomes relative to completion (Hien et al., 2012). These results add to an emerging body of literature suggesting that treatment discontinuation is not necessarily an indicator of nonresponse.

The current study examined attendance patterns and their relations with treatment outcome in a randomized controlled trial evaluating the efficacy of exercise as an adjunctive intervention for smoking cessation among individuals with high anxiety sensitivity (AS). The core outcome analysis showed that participants high in AS randomized to exercise were more likely to remain abstinent following quit day and session attendance showed an overall positive association with abstinence (Smits et al., 2016). The present analysis tested whether qualitatively distinct attendance patterns could be identified using a person-centered cluster analytic approach, and whether these empirically-derived patterns moderated the effect of treatment on abstinence.

## 2. METHODS

### 2.1 Participants

Participants were 136 (52.2% female, Age<sub>M</sub>=44.2 years [*SD*=11.3 years]) adult daily sedentary smokers (average of 19.4 [*SD*=9.7] cigarettes per day) with elevated AS who were motivated to quit. A complete description of eligibility criteria and participant demographics and smoking characteristics are presented in Smits et al. (2012, 2016).

### 2.2 Interventions

All participants received a standard treatment (Fiore, 2000; Zvolensky et al., 2008) of seven weekly 60-minute sessions of cognitive behavioral therapy for smoking cessation and optional nicotine replacement therapy (NRT). Additionally, participants were randomized to a vigorous-intensity exercise intervention or a wellness education intervention, each consisting of three weekly 25-minute sessions for 15 weeks. All together, each session included treatment (either exercise or wellness education), therapist support, and optional NRT patches. For a detailed description of the procedures see (Smits et al., 2012).

### 2.3 Attendance

Participants were coded as either *active* or *inactive* for each of the 15 weeks of treatment. To be coded *active* completion of at least one of the three weekly sessions was required. We used weekly attendance (as opposed to using the 45 individual sessions as the repeated measure) because: 1) Key milestones (e.g., preparing for quit, target quit week, relapse prevention, follow-up) were defined on a week-by-week (not session-to-session) basis and 2) Fitting the model required equally spaced time points between participants.

### 2.4 Abstinence

Self-reported smoking status was verified by expired carbon monoxide at weekly visits, and with saliva cotinine at follow-up (SRNT Subcommittee on Biochemical Verification, 2002).

If biological verification was not available to verify self-report, abstinence was considered missing data (Blankers et al., 2016). Point prevalence abstinence (PPA) was defined as no smoking, not even a puff, in the 7 days prior to any assessment. Failure to maintain prolonged abstinence (PA) at any assessment was defined by 7 or more consecutive days of smoking or smoking at least 1 cigarette over the 2 consecutive weeks prior to the assessment (Hughes et al., 2003; Smits et al., 2016).

## 2.5 Data Analyses

Latent class growth analysis (LCGA) in Mplus version 7 (Muthén and Muthén, 1998) tested the hypothesis that multiple patterns of weekly attendance would characterize the sample better than a single pattern. Weekly attendance was modeled across 15 weeks of treatment with a discontinuity at quit week. This piecewise approach mirrors the current and previous outcome models. Model information criteria, entropy, the adjusted Lo-Mendel-Rubin likelihood ratio test, and parsimony were all considered in the evaluation of model fit. Posterior probabilities of the best fitting model determined individual attendance pattern assignments.

Following Smits et al., (2016) two dichotomous measures of smoking behavior (PPA and PA) were examined in a three-phase (i.e., pre-quit, post-quit, post-treatment) generalized linear mixed model (GLMM) following the intent-to-treat approach recommended for smoking cessation trials (Hall et al., 2001). Attendance pattern, treatment condition, AS, and two-way interactions were included as predictors. To minimize Type II error, provide a more parsimonious model, and more clearly elucidate the overall relations between the predictors and abstinence, non-significant interaction terms were removed (Baldwin et al., 2009; Cohen, 1983).

## 3. RESULTS

### 3.1 Attendance Patterns

The 3-class LCGA provided the best fit with lowest information criteria, high entropy (0.96) suggestive of strong delineation of classes, and a significant adjusted Lo-Mendel-Rubin likelihood ratio test,  $p=.01$ . Three distinct attendance patterns were identified: Completers ( $n=63$ , 46.3%) had high probability of attending throughout the entire treatment duration, Titrators ( $n=32$ , 23.5%) showed a gradual decline in probability of attending throughout the 15 weeks of treatment, and Droppers ( $n=41$ , 31.1%) had a high probability of dropout within the first few weeks of treatment (Figure 1). The distribution of participants following each attendance pattern was significantly different between treatments,  $\chi^2(2)=7.46$ ,  $p=.02$ . Specifically, there was a difference in the proportion of participants within each treatment who were Completers (exercise:  $n=26$ , 36.1% vs. control:  $n=37$ , 57.8%) or Droppers (exercise:  $n=28$ , 38.9% vs. control:  $n=13$ , 20.3%), whereas Titration proportions were not significantly different (exercise:  $n=18$ , 25.0% vs. control:  $n=14$ , 21.9%). On weeks that participants were actively attending treatment, the average number of sessions attended was 2.51 sessions, 63% attended all 3 weekly sessions, 25% attended 2 out of the 3 weekly sessions, and 12% attended only one of the 3 weekly sessions.

### 3.2 Abstinence Outcomes

Subsequent analysis of the relation between treatment attendance pattern and abstinence was restricted to the Completer versus Titrator since Droppers withdrew prior to quit week. The final model yielded a significant attendance pattern by treatment interaction,  $\beta=0.758$ , 95% CI [-0.293, 1.223],  $t(3047)=3.195$ ,  $p=.001$  (Figure 2). Although the probability of abstinence at post-treatment was not significantly different between Completers and Titrators in the exercise condition,  $\beta=0.248$ , 95% CI [-0.086, 0.583],  $t(3047)=1.455$ ,  $p=0.146$ , Completers in the control condition were more likely to be abstinent than Titrators,  $\beta=1.006$ , 95% CI [0.683, 1.329],  $t(3047)=6.102$ ,  $p<.001$ . Moreover, among Completers, there were no significant differences between those in the exercise vs. the control condition,  $\beta=0.120$ , 95% CI [-0.104, 0.344],  $t(3047)=1.054$ ,  $p=.292$ , whereas Titrators in the exercise condition were more likely to be abstinent than Titrators in the control condition,  $\beta=0.637$ , 95% CI [0.238, 1.037],  $t(3047)=3.127$ ,  $p=.002$ . Full model statistics are reported in Supplementary Material<sup>1</sup>.

## 4. DISCUSSION

Three distinct attendance patterns were empirically-derived in a smoking cessation trial: 1) Droppers attended only the first few weeks of treatment, 2) Titrators gradually reduced their attendance, and 3) Completers attended throughout the entire treatment. Within each treatment, there were fewer Completers and more Droppers in the exercise relative to control condition, whereas similar proportions of Titrators were observed across treatments. Although Droppers lacked outcome data, subsequent analyses of abstinence rates showed that Titrators did not necessarily show poorer outcomes compared to Completers.

Consistent with the GEL model (Hien et al., 2012; Reese et al., 2011), Titrators in the exercise condition had cessation outcomes that were not significantly different than for those completing the intervention, despite attending fewer sessions. Exercise may assist smoking cessation by mitigating anxiety during acute withdrawal symptoms (Leventhal and Zvolensky, 2015), which may be most pronounced after the initial quit attempt. Since success with abstinence within the first 24 hours after quit is predictive of continued abstinence (Perkins, 2014), Titrators who were likely to remain engaged in the exercise intervention through quit week may have benefited comparably to Completers despite lower overall attendance. Given evidence of rapid benefits from exercise on anxiety, mood, and anxiety sensitivity in other studies (Medina et al., 2014; Smits et al., 2008), exercise may exert its influence on risk factors for smoking relapse in only a few sessions early on in treatment.

Interestingly, our analysis provided no evidence of differential treatment effects among Completers. It is possible that the treatments themselves confer comparable benefits at this dosage, or that treatment completion marks individuals who are highly motivated, both in terms of completing the intervention and remaining abstinent. Future studies that manipulate treatment dose would allow testing of causal relations. However, Titrators in the control condition showed lower rates of abstinence compared to control Completers, suggesting that

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<sup>1</sup>Supplementary material can be found by accessing the online version of this paper at <http://dx.doi.org> and by entering doi:...

the wellness education-augmented intervention may exert its effects *vis-à-vis* ongoing social support and accountability. Thus, attendance through the post-quit phase may be necessary to optimize benefits.

It is important to note there were fewer Completers and more Droppers in the exercise relative to control condition, whereas similar proportions of Titrators were observed across treatments. The disproportionate number of Droppers in the exercise condition may indicate that the exercise intervention was more aversive or challenging to adhere to. If so, higher motivation to engage with the intervention or remain abstinent among the Titrators and Completers in the exercise condition may again provide an alternative explanation for the differences in abstinence rates.

The findings reported here expand on those reported in the main outcome paper (Smits et al., 2016) by showing that the relation between attendance patterns and treatment success may not be linear and, importantly, may depend on the type of intervention. Nevertheless, several limitations should be noted. The original study was not designed to compare intervention lengths, thus results reflect participant-determined attendance patterns as opposed to “prescribed” treatment dosage. Furthermore, since the study was not designed to compare treatment dosage, it was not powered specifically for the present analysis; therefore, the lack of statistical differences between attendance patterns in the exercise condition may be a reflection of inadequate power to detect small differences. Thus, while intriguing and hypothesis generating, these findings require replication and further study. Additionally, since Droppers were excluded from abstinence analyses due to lack of outcome data, our ability to capture the full scope of the relationship between treatment attendance and outcome was limited. Future studies may benefit from increasing participant engagement with data collection after dropout to better understand the reasons for early dropout and the outcome after a brief dose of treatment.

Together, the present findings show that treatment attendance patterns can be empirically-derived and related to efficacy, helping to generate testable hypotheses for follow-up studies that aim to refine interventions. Future studies can also examine individual characteristics that interact with treatment length to predict outcomes, which is critical to interventions with disproportionate level of Droppers, as was observed in the current exercise condition. Importantly, an improved understanding of participants’ reasons for treatment discontinuation may help inform approaches to either re-engagement when desired outcomes have not been achieved, or to the maintenance of gains among early responders. In conclusion, our results add to the growing literature suggesting that optimal treatment dosage may vary as a function of individuals’ improvement rate.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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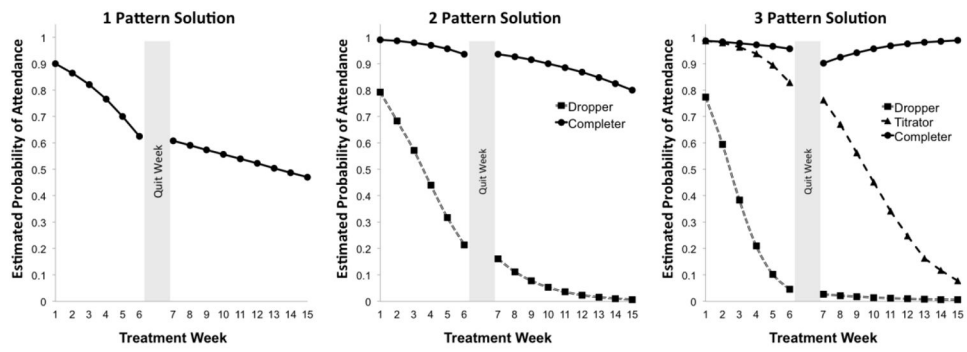
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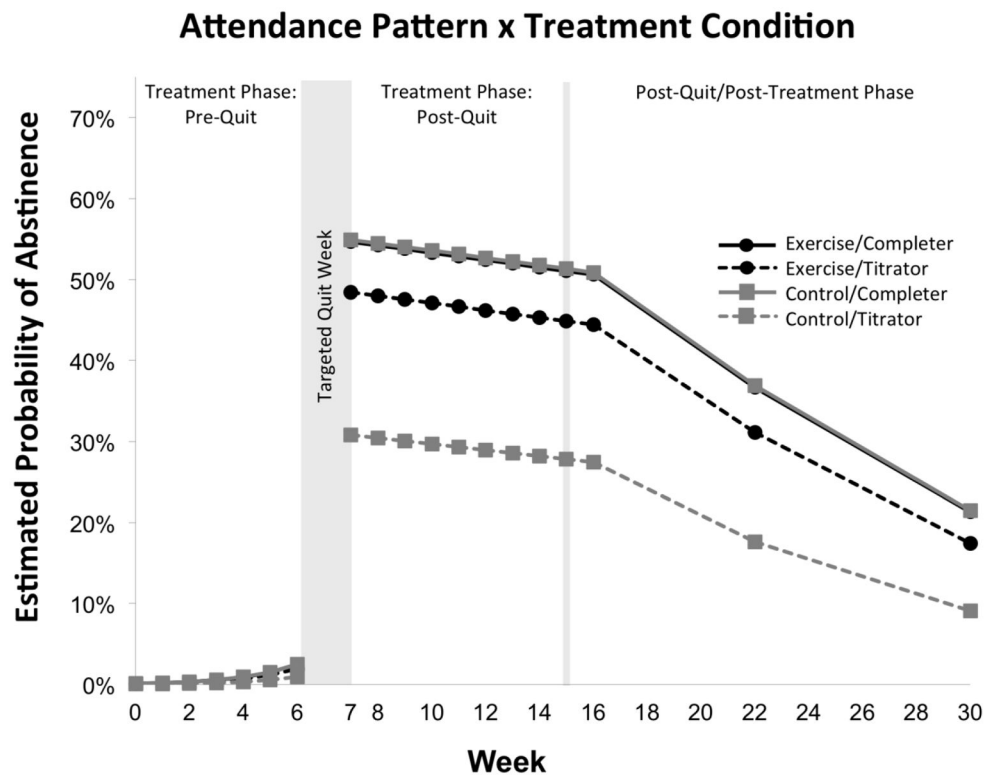


### HIGHLIGHTS

- Attendance was characterized by three patterns; Completers, Titrators, and Droppers
- Titration was associated with lower quit success within the control condition
- Titrators and Completers had similar quit success within the exercise intervention



**Figure 1.** Each panel in Figure 1 depicts a step in the latent growth class modeling analysis. Each step in the analysis allows for an additional cluster of individuals who followed a similar attendance pattern. The 3 pattern solution provides the most accurate description of participant’s engagement over the 15-week intervention



**Figure 2.** Estimated probability of abstinence throughout the 30-weeks of treatment for participants by treatment condition and Titrator or Completer attendance patterns. The analysis indicated an attendance pattern by treatment condition interaction at the end of treatment and at 6-month follow-up such that only Titrators in the control condition had significantly lower probability of quit success. ASI was centered at high ASI (ASI=23).