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Short communication

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

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ABSTRACT

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.

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;

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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 post-traumatic 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 $_{M}$ = 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-min 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-min 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, $p = 0.01$. 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 (Fig. 1). The distribution of participants following each attendance pattern was significantly different between treatments, $\chi^2(2) = 7.46$, $p = 0.02$. 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 Titrator 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%