Evaluation of smokers with and without asthma in terms of smoking cessation outcome, nicotine withdrawal symptoms, and craving: Findings from a self-guided quit attempt

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HIGHLIGHTS

• Smokers with and without asthma were compared during a self-guided quit attempt.
• There were no group differences in abstinence rates or likelihood of smoking lapse.
• Smokers with asthma had a slower rate of decline in nicotine withdrawal and craving.

ARTICLE INFO

ABSTRACT

Introduction: The aim of the current study was to evaluate smoking cessation outcome, nicotine withdrawal symptoms, and craving between smokers with ($n = 47$; 46.8% male, $M_{age} = 40.0$ years, $SD = 11.7$) and without ($n = 45$; 51.1% male, $M_{age} = 37.5$ years, $SD = 11.1$) asthma during a self-guided quit attempt.
Methods: After completing a baseline assessment visit, participants attended study sessions on their scheduled quit day as well as follow-up visits (3 days, 7 days, 14 days, and 28 days) after their quit day.
Results: Smokers with and without asthma did not differ in abstinence rates, smoking lapse, and rate of change in urge to smoke to reduce negative affect. However, smokers with asthma demonstrated a slower rate of decline in nicotine withdrawal symptoms and craving over time.
Conclusions: These findings suggest that smokers with asthma may benefit from specialized smoking cessation treatments to address prolonged withdrawal symptoms and craving.

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1. Introduction

Despite the known negative health effects of smoking, cigarette smoking is more common among individuals with asthma compared to those without (Gwynn, 2004; McLeish, Cougle, & Zvolensky, 2011). Not surprisingly, smoking negatively impacts asthma, resulting in greater asthma severity, poorer asthma control, increased risk of morbidity and mortality, more frequent healthcare utilization, and decreased effectiveness of inhaled corticosteroids (Althuis, Sexton, & Prybylski, 1999; Chaudhuri et al., 2008; Eisner & Iribarren, 2007; Lazarus et al., 2007; McLeish & Zvolensky, 2010; Siroux, Pin, Oryszczyn, Le Moual, & Kauffmann, 2000). Although quitting smoking results in significant

improvements in lung function, reductions in asthma medication use, and improved quality of life (Chaudhuri et al., 2006; Tønnesen et al., 2005), there is highly limited empirical data focused on smoking cessation among individuals with asthma.

In the earliest study, fourteen smokers with asthma completed a self-guided quit attempt and only 50% were able to remain quit for only 24 hours and the other half for only 7 days (Fennerty, Banks, Ebden, & Bevan, 1987). Tønnesen et al. (2005) also found that a substantial percentage (76.8%) of smokers with asthma trying to quit using nicotine replacement therapy (NRT) were not abstinent at the end of 4 months. Most recently, Gratziou et al. (2014) retrospectively evaluated the effectiveness of an intensive smoking cessation program among smokers with and without a history of pulmonary disease or respiratory symptoms in Greece. Participants received pharmacotherapy for 8–12 weeks and nine sessions of individualized counseling over the course of a year after their quit date. Results indicated that there were no group

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differences in abstinence rates, suggesting asthma may not negatively impact smoking cessation outcomes.

Although past work provides important information on asthma and smoking cessation, the empirical literature is limited in a number of key respects. First, there has not been a prospective evaluation comparing abstinence rates among smokers with and without asthma. Second, in the only between group test, Gratziou et al. (2014) did not directly compare smokers with asthma to those without a history of pulmonary disease. Rather, they combined smokers with asthma and smokers with COPD and compared this larger group of smokers with lung disease to smokers without lung disease. Third, as nearly two-thirds of smokers try to quit without treatment (Centers for Disease Control [CDC], 2011; Hughes, 2003) it is important to understand how smokers with and without asthma compare in cessation success during a self-guided quit attempt (i.e., unaided by treatment). Finally, factors other than abstinence rates have yet to be explored, including such processes as withdrawal symptoms and craving. The examination of such factors is clinically relevant, as they are routinely among the most consistent predictors of cessation success (Allen et al., 2008).

Together, the aim of the current study was to compare smoking cessation rates, changes in nicotine withdrawal symptoms, and changes in craving between smokers with and without asthma during a self-guided quit attempt. It was hypothesized that, after controlling for participant race and level of pre-cessation nicotine dependence, smokers with asthma, compared to those without, would have a (1) shorter time to first lapse to smoking; (2) lower point-prevalence abstinence (PPA) rates; (3) slower rate of decrease in nicotine withdrawal symptoms over the 28-day follow-up period; and (4) slower rate of decrease in craving (i.e., desire to smoke and urges to smoke to reduce negative affect) over the 28-day follow-up period. These hypotheses were developed based on extant biopsychosocial models and empirical evidence focused on asthma indicating that persons with this medical condition tend to be fearful of pulmonary-based and other bodily sensations (Goodwin, Jacobi, & Thefeld, 2003; Hasler et al., 2005) and may react with greater levels of anxiety or related negative affect when confronted with such stressors (McLeish, Luberto, & O'Bryan, 2016). As a result, smokers with asthma may be prone to be emotionally reactive and regulate their affect via functionally-oriented self-regulation tactics that may paradoxically amplify unwanted symptoms (i.e., escape and avoidance). Thus, smokers with asthma are likely to be especially sensitive and emotionally reactive to smoking deprivation and the ensuing nicotine withdrawal-related aversive interoceptive cues that routinely occur during smoking abstinence; particularly in the early stages of a quit attempt where such aversive internal cues are most likely to be present.

2. Methods

2.1. Participants

Participants were 92 daily cigarette smokers between the ages of 18 and 65. For inclusion in the study, participants had to: (1) be a regular smoker for at least one year; (2) be currently smoking at least 10 cigarettes per day; (3) have expired carbon monoxide (CO) levels of at least 8 parts per million (ppm) at the baseline assessment; (4) report a motivation to quit smoking of at least 5 on a 10 point scale; and (5) be interested in quitting smoking in the next month. Participants were excluded from the study based on: (1) current substance dependence (excluding nicotine dependence); (2) decreased smoking rate by more than a half in the past six months; (3) current use of or intention to use nicotine replacement therapy, bupropion, or varenicline; or (4) regular, current use of other tobacco products. Participants in smokers without asthma group were eligible if they did not have a lifetime history of asthma. Participants in the smokers with asthma group were required to have received a physician diagnosis of asthma prior to the onset of smoking and meet criteria for asthma diagnosis verification using spirometry.

2.1.1. Smokers with asthma

The smokers with asthma group ($n = 47$; 46.8% male, $M_{age} = 40.0$ years, $SD = 11.7$) was 36.2% Caucasian, 61.7% African American, and 2.1% Native Hawaiian or other Pacific Islander. No participants endorsed Hispanic ethnicity. In terms of education, 54.3% had a high school degree or less, 28.3% had completed some college education, 13.0% had a 2- or 4-year college degree, and 4.4% had completed some graduate school education or had a graduate degree. On average, smokers with asthma considered themselves regular smokers by the mean age of 18.9 ($SD = 5.7$), had been regular smokers for 21.6 years ($SD = 11.3$) and were 9.0 ($SD = 7.9$) years of age when diagnosed with asthma. Participants reported having made an average of 3.81 ($SD = 3.42$) serious quit attempts and that the average length of their longest quit attempt was 207.8 ($SD = 409.1$) days.

2.1.2. Smokers without asthma

The smokers without asthma group ($n = 45$; 51.1% male, $M_{age} = 37.5$ years, $SD = 11.1$) was 60.0% Caucasian, 35.6% African American, and 4.4% American Indian or Alaskan Native. 2.5% of participants reported Hispanic ethnicity. In terms of education, 44.4% had a high school degree or less, 42.2% had completed some college education or were current college students, 8.9% had a 2- or 4-year college degree, and 4.4% had completed some graduate school education or had a graduate degree. On average, smokers without asthma considered themselves regular cigarette smokers by a mean age of 18.9 ($SD = 6.9$) years and had been regular smokers for 18.1 years ($SD = 10.5$). Participants reported having made an average of 3.4 ($SD = 3.42$) serious quit attempts and that the average length of their longest quit attempt was 2316 ($SD = 629.1$) days.

2.2. Measures

2.2.1. Asthma diagnosis

Asthma status was verified by spirometry assessed using a KoKo Legend portable office spirometer (nSpire Health, Inc., Longmont, CO). Based on current guidelines (National Heart Lung and Blood Institute, 2007), individuals who demonstrated significant airflow obstruction, as indicated by a reduction in values for forced expiratory volume in 1 s (FEV_1) and the ratio of FEV_1 to forced vital capacity (FVC) relative to predicted values, with 12% or greater improvement after administration of short-acting bronchodilator (or 20% or greater improvement in forced expiratory flow 25–75% [FEF_{25-75}]) were considered to have a positive asthma status (Alberts, Ferris, Brooks, & Goldman, 1994).

2.2.2. Expired carbon monoxide (CO)

Biochemical verification of smoking status was completed by CO analysis of breath samples assessed using a Bedfont Micro 4 Smokerlyzer CO Monitor (Model EC50; coVita, Haddonfield, NJ). Research indicates that 8 ppm is an optimal cutoff score for reliably discriminating smoking status (Benowitz et al., 2002). Obtained values at or above this cutoff were considered indicative of regular smoking and scores of 7 ppm or less were considered indicative of smoking abstinence.

2.2.3. Fagerström Test for Nicotine Dependence (FTND)

The FTND (Heatherton, Kozlowski, Frecker, & Fagerström, 1991) is a 6-item measure designed to assess gradations in nicotine dependence. The FTND has shown good internal consistency, positive relations with key smoking variables (e.g., cotinine; Heatherton et al., 1991; Payne, Smith, McCracken, McSherry, & Antony, 1994) as well as high degrees of test-retest reliability (Pomerleau, Carton, Lutzke, Flessland, & Pomerleau, 1994).

2.2.4. Motivational Aspects of Smoking Cessation (MASC)

The MASC is an 11-item self-report measure that assesses the degree to which participants are motivated to quit smoking (Rundmo,

Smedslund, & Götestam, 1997). For the first ten items, participants are asked to rate their motivation to quit smoking using specific strategies on a 5-point Likert-type scale from 0 = *no, not at all motivated* to 4 = *yes, very motivated*. The last question asks participants to rate their overall interest to quit smoking on a 0 (*no interest*) to 100 (*complete interest in stopping*) scale. The MASC has demonstrated good internal consistency and validity (Rundmo et al., 1997).

2.2.5. Minnesota Nicotine Withdrawal Scale (MNWS)

The MNWS (Hughes & Hatsukami, 1986) is a 9-item self-report measure that assesses severity of nicotine withdrawal symptoms. Participants are asked to rate how much they currently experience each symptom on a 5 point (0 = *none* to 4 = *severe*) Likert-type scale. The MNWS has shown good reliability and predictive validity (Hughes, 1992; Hughes, Gust, Skoog, Keenan, & Fenwick, 1991).

2.2.6. Brief Questionnaire of Smoking Urges (QSU)

The QSU (Cox, Tiffany, & Christen, 2001) is a 10-item self-report measure that assesses craving to smoke. Participants are asked to rate their level of agreement from 0 (*strongly disagree*) to 100 (*strongly agree*). The QSU has a two-factor structure with factor one items representing desire and intention to smoke ("I have a desire for a cigarette right now") and factor two items representing an anticipated relief from negative affect ("Smoking would make me less depressed"). The QSU has demonstrated good reliability and predictive validity (Cox et al., 2001).

2.3. Procedure

Participants were recruited through community-based advertisements (e.g., flyers, newspaper, and online advertisements) and targeted recruitment letters mailed to any individual in the university medical center system whose electronic medical record indicated that they had an asthma diagnosis and were a smoker. Individuals interested in participating in the study were first screened by phone and, if eligible, were scheduled for an in-person baseline assessment visit. After providing informed, written consent, participants' smoking status was biochemically verified via CO analysis, and participants in the smokers with asthma group had their asthma status objectively verified via spirometry. Participants then completed a battery of self-report measures and scheduled their quit day for approximately one week from their baseline visit. At the quit day visit participants had their smoking status verified via CO analysis and then completed a series of self-report questionnaires. Participants attended follow up visits 3 days, 7 days, 14 days, and 28 days after their quit day. At each follow-up visit, participants had their smoking status verified via CO analysis and completed self-report measures of nicotine withdrawal and craving. Participants were compensated $50 for completing the baseline study visit and $30 at the quit day and each of the follow-up visits after their quit day. In order to increase the likelihood that participants would make a concerted effort at smoking cessation on their specified quit date, participants who abstained from smoking for 12 h prior to the quit day visit were compensated an additional $20. The Institutional Review Board approved all study procedures and materials prior to data collection.

2.4. Data analytic strategy

Analysis of variance (ANOVA) and chi-square analyses were conducted in order to examine differences in relevant baseline covariates and group status in terms of attendance to the four follow-up visits. Results indicated no statistically significant differences on all tested variables, including asthma group status, race, gender, or pre-cessation levels of nicotine dependence and motivation to quit. Next, prospective abstinence outcome data (point-prevalence abstinence [PPA]; time to lapse) were prepared. PPA was determined based on self-reported smoking abstinence, verified by expired CO levels <8 ppm. PPA was

assessed at quit day and all post-quit follow-up study visits. It was assumed that the presence of missing smoking status data indicated cigarette use. From these data, a dichotomously-coded variable was created using self-reported smoking status and expired CO to indicate the occurrence of "any lapse" during the 28-period after quit day. Then, a variable was created indexing the "days to first lapse", or number of days from quit day to the first lapse, based on self-reported smoking behavior.

To examine group differences in time to lapse to smoking during the 28-day follow-up period, a Cox proportional-hazard regression analysis was used using the "any lapse" and "days to first lapse" variables described above. To examine group differences in abstinence rates over time, an analysis of PPA across the follow-up time points was conducted using multi-level mixed modeling (MLM), specifically with a binary distribution. The model was constructed to include the main effect of asthma status, time, and their interaction in predicting abstinence likelihood. An autoregressive covariance matrix for time was specified. To examine group differences over time in changes in nicotine withdrawal symptoms and craving, three MLM models were constructed to include the main effect of asthma status, time, and their interaction in predicting nicotine withdrawal, desire to smoke, and urge to smoke to reduce negative affect. A random slope was specified in each model such that the slope was allowed to vary by subject. The association between time points (i.e., the residual correlations across days) was specified as unstructured. In all models, time was centered at quit day (day 0). Race and nicotine dependence were entered as time-invariant a priori covariates and asthma status was entered as the primary predictor in all models.

3. Results

3.1. Time to smoking lapse and abstinence likelihood by asthma status

Please see Table 1 for a summary of the baseline descriptive data and rates of PPA on quit day and throughout the follow-up period. At baseline, prior to quitting, smokers with asthma, relative to those without, did not significantly differ in terms of daily smoking rate, level of nicotine dependence, or motivation to quit smoking. Overall, 83% of the sample lapsed during the 28-days post-quit. Regarding time to first lapse, the median survival time for the entire sample was 2.1 days, with 71.3% lapsing on quit day (Day 0). Among smokers with asthma, 69.6% lapsed on quit day and the median time to lapse was 2.2 days. Among smokers without asthma, 68.8% lapsed on quit day and the median time to lapse was 2.0 days. The model with covariates was non-significant. There was a non-significant effect for non-white race ($OR = 0.90$, $CI_{95\%} = 0.58$–1.39) and nicotine dependence ($OR = 1.07$,

Table 1
Baseline descriptive data and rates of PPA by asthma group status.

	t	Asthma n = 48 M (SD)	No asthma n = 45 M (SD)
Baseline CPD	−1.09	22.0 (21.89)	18.0 (10.94)
FTND	0.96	5.7 (2.49)	6.0 (1.65)
Motivation	0.86	74.2 (31.37)	79.7 (29.09)
	Total N	Asthma % Abstinent (n)	No asthma % Abstinent (n)
Quit Day (Day 0)	94	39.6% (19)	45.7% (21)
Day 3	73	28.2% (11)	23.5% (8)
Day 7	82	27.9% (12)	20.5% (8)
Day 14	79	30.8% (12)	10.0% (4)[*]
Day 28	75	27.0% (10)	21.1% (8)

Note. CPD = cigarettes per day; FTND: Fagerström Test for Nicotine Dependence. (Heatherton et al., 1991); Motivation: baseline motivation to quit smoking using the Motivational Aspects of Smoking Cessation Questionnaire (Rundmo et al., 1997).

[*] $p < 0.05$.

$CI_{95\%} = 0.97$–1.19), but asthma status did not increase the risk of time to lapse ($OR = 0.95$, $CI_{95\%} = 0.66$–1.56).

A series of chi-square analyses indicated that smokers with and without asthma did not differ in terms of PPA on quit day or during the follow up period, with the exception of day 14 post-quit. At this time point only, the rate of smoking abstinence was significantly higher among smoker with asthma (30.8%) relative to those without (10.0%; $X^2(1) = 5.274$, $p = 0.022$). Results of the MLM analyses examining group differences in likelihood of PPA over time showed a non-significant effect of group on smoking abstinence at quit day ($b = -0.20$, $p = 0.726$). Nicotine dependence and race were non-significant predictors of abstinence likelihood on quit day. There was a significant effect of time ($b = -0.42$, $p = 0.014$), such that smoking abstinence likelihood significantly decreased over time. The interaction of time × asthma status was non-significant ($b = 0.14$, $p = 0.555$), indicating the likelihood of abstinence did not change over time as a function of asthma status.

3.2. Changes in nicotine withdrawal and craving by asthma status

Results revealed a significant effect of asthma group status on quit day (intercept; $b = 3.95$, $p = 0.021$), such that smokers without asthma had significantly higher quit day subjective ratings of nicotine withdrawal relative to smokers with asthma (see Table 2). There were no significant effects on quit-day withdrawal by race, but there was a significant effect for level of nicotine dependence with higher pre-quit levels of nicotine dependence being associated with higher quit day levels of nicotine withdrawal ($b = 0.82$, $p = 0.018$). Nicotine withdrawal significantly decreased over time during the quit period. The rate of change for smokers with asthma was not significant, but was significant for smokers without asthma. To test if reductions in withdrawal over time differed as a function of asthma status, the interaction of group × time was examined. A plot of the interaction and test of differences in slope effects (Fig. 1) reveled a significant interaction effect ($b = -1.16$, $p = 0.027$), indicating that the rate of decline in withdrawal was steeper (faster) for smokers without asthma relative to those with asthma.

Results indicated that there were no significant effects of the covariates or significant group differences in terms of quit day desire to smoke (see Table 2). There was a significant decrease in desire to smoke during the quit period. Here, both smokers without asthma ($b = -7.88$, $p < 0.001$) and smokers with asthma ($b = -4.59$, $p < 0.001$) evidenced significant reductions in desire to smoke over time. The test of the group × time interaction revealed a significant interaction effect ($b = -3.29$, $p = 0.026$), indicating that the rate of decline in desire to smoke occurred more quickly over time for smokers without asthma, relative to those with asthma (see Fig. 2).

In terms of urges to smoke to reduce negative affect, results revealed no significant group differences in terms of quit day urges to smoke to alleviate negative affect, nor were there significant effects for the covariates (see Table 2). There was a significant main effect of time; both
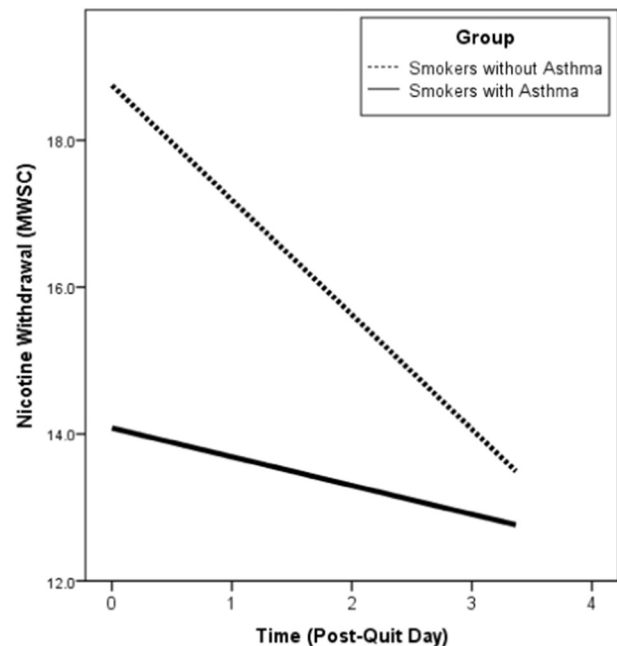

Fig. 1. Interaction of asthma status by time in terms of nicotine withdrawal.

smokers without asthma ($b = -3.74$, $p < 0.001$) and smokers with asthma ($b = -3.23$, $p = 0.002$) reported reductions in urges to smoke to alleviate negative affect over time. The test of the interaction revealed that the rate of change in urges to smoke to alleviate negative affect did not significantly differ as a function of asthma group status ($b = -0.51$, $p = 0.721$).

4. Discussion

The current study sought to prospectively compare cessation rates, nicotine withdrawal symptom severity, and craving among smokers with and without asthma during a self-guided quit attempt. Results indicated that smokers with asthma did not differ in terms of abstinence likelihood or risk for smoking lapse during the 28-day follow-up period compared to smokers without asthma. Although in contrast to our prediction, such findings are in line with the results of Gratziou et al. (2014) who employed retrospective assessments of smoking cessation behavior. Yet, consistent with prediction, smokers with asthma, relative to smokers without asthma, experienced a slower rate of decline in subjective nicotine withdrawal symptom severity and desire to smoke during the cessation attempt. However, the rate of change in urges to smoke to reduce negative affect did not differ between the two groups.

The present results suggest that smokers with asthma do not differ from smokers without asthma in their ability to quit smoking in the

Table 2
Fixed effects estimates from multi-level models for nicotine withdrawal and smoking urges.

	MNWS			QSU-Desire			QSU-NA		
	Effect estimate	SE	p	Effect estimate	SE	p	Effect estimate	SE	p
Race	−1.50	1.49	0.32	−2.86	4.33	0.51	−1.04	3.61	0.77
FTND	0.82	0.34	0.02*	−0.28	0.99	0.78	0.97	0.82	0.24
Group	3.95	1.69	0.02*	8.26	5.22	0.12	0.89	4.45	0.84
Time	−0.40	0.37	0.28	−4.59	1.14	0.00**	−3.23	1.00	0.00**
Group * Time	−1.16	0.51	0.03*	−3.29	1.62	0.04*	−0.51	1.42	0.72

Note SE: standard error; Race: 0 = White; 1 = non-White; FTND: Fagerström Test for Nicotine Dependence (Heatherton et al., 1991), centered; Group: estimate for smokers without asthma; Time: log transformed rate of change in outcome variable for smokers with asthma; MNWS: Minnesota Nicotine Withdrawal Scale (Hughes & Hatsukami, 1986); QSU-Desire: Brief Questionnaire of Smoking Urges scale- Desire to smoke subscale (Cox et al., 2001); QSU-NA: Brief Questionnaire of Smoking Urges scale- Negative affect reduction subscale (Cox et al., 2001).
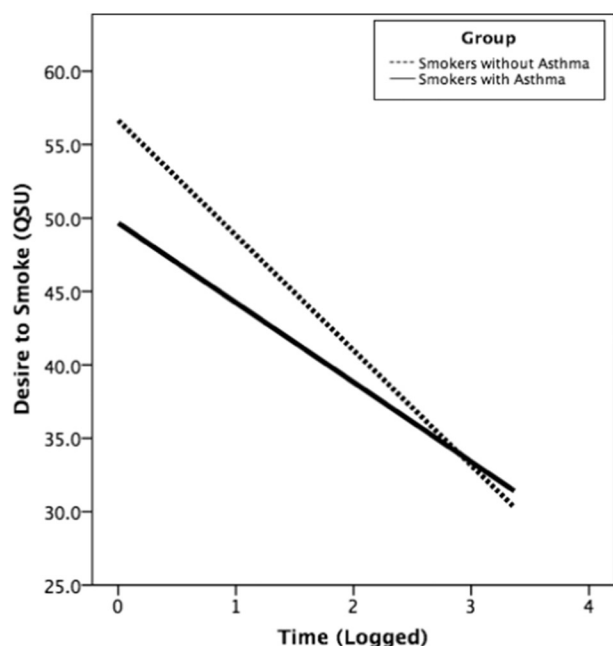
  * $p < 0.01$.
  ** $p < 0.01$.

Fig. 2. Interaction of asthma status by time in terms of desire to smoke.

first month of a self-guided quit attempt. In fact, PPA rates for smokers with asthma were higher than for smokers without asthma at the 14-day follow-up visit. The fact that this potential trend for a decreased risk for lapse and relapse to smoking for smokers with asthma was not maintained may be attributable to the fact that smokers with asthma did not experience the same rate of decrease in severity of withdrawal symptoms and desire to smoke as smokers without asthma. It is possible that this slower decrease in symptoms is the reason why the higher abstinence rates were not maintained in the smokers with asthma group beyond the 14-day follow-up visit. Specifically, the slower decline in withdrawal and craving may be a result of a greater tendency to experience a persistence of 'internal smoking-specific distress' among smokers with asthma.

There are a number of study limitations that warrant consideration. First, the sample, by design, consisted of regular daily smokers who smoked at least 10 cigarettes per day, limiting the generalizability of the results to individuals who smoke less than that or do not smoke on a daily basis. Second, participants underwent a self-guided quit attempt and no formal treatment was provided. Although most smokers attempt to quit smoking on their own (Hughes, 2003), it will be important for future studies to compare smokers with and without asthma on smoking cessation outcomes after receiving treatment. Finally, participants were only followed for 1 month after quitting. Although research demonstrates that most relapses to smoking occur during the first two weeks of a quit attempt (Garvey, Bliss, Hitchcock, Heinold, & Rosner, 1992; Hughes et al., 2014), given the significant group differences in PPA rates at the 14-day follow-up visit, it will be important to follow participants for longer periods of time to see how these patterns of abstinence as well as nicotine withdrawal and craving symptom severity change over longer time periods.

5. Conclusions

Overall, results from the current study indicate that despite similar cessation rates, smokers with asthma experience slower decreases in nicotine withdrawal symptom severity and desire to smoke during a quit attempt. Accordingly, smokers with asthma may benefit from using nicotine replacement therapy, possibly for an extended period of time and psychoeducation to prepare them for these slower declines in withdrawal symptoms and craving.

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