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A Test of the Stress-Buffering Model of Social Support in Smoking Cessation: Is the Relationship Between Social Support and Time to Relapse Mediated by Reduced Withdrawal Symptoms?

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Abstract

Introduction: Social support has been linked to quitting smoking, but the mechanisms by which social support affects cessation are poorly understood. The current study tested a stress-buffering model of social support, which posits that social support protects or "buffers" individuals from stress related to quitting smoking. We hypothesized that social support would be negatively associated with risk of relapse, and that this effect would be mediated by reduced withdrawal and depressive symptoms (i.e., cessation-related stress) over time. Further, we predicted that trait neuroticism would moderate this mediational effect, such that individuals high in negative affectivity would show the greatest stress-buffering effects of social support.

Methods: Participants were weight-concerned women (n = 349) ages 18–65 enrolled in a randomized, double-blind, placebo-controlled smoking cessation trial of bupropion and cognitive behavioral therapy. Social support was assessed at baseline, and biochemically-verified abstinence, withdrawal-related symptoms, and depressive symptoms were assessed at 1-, 3-, 6-, and 12-months follow-up.

Results: Social support was negatively related to risk of relapse in survival models and negatively related to withdrawal symptoms and depression in mixed effects models. These relationships held after controlling for the effects of pre-quit day negative affect and depression symptoms, assignment to treatment condition, and number of cigarettes smoked per day. A temporal mediation model showed that the effect of social support on risk of relapse was mediated by reductions in withdrawal symptoms over time but not by depression over time. Contrary to hypotheses, we did not find that neuroticism moderated this mediation effect.

Conclusions: Increased social support may buffer women from the harmful effects of cessation-related withdrawal symptoms, which in turn improve cessation outcomes.

Introduction

Social support is an important determinant of successful smoking cessation. For instance, a wealth of data shows that a lack of

naturally occurring social support (i.e., support systems that already exist in the smokers' natural environment, such as family, friends, and coworkers[1]) predicts smoking relapse.[1–10] Despite evidence

linking naturally occurring social support to quitting success, interventions designed to increase social support for quitting smoking have been largely ineffective.[11,12] The failure of social support interventions to affect relapse may be due to the lack of a theoretical framework to guide the design of interventions aimed at improving social support.[11,13] Thus, recent recommendations suggest the need to examine *how* social support affects smoking cessation outcomes and for whom support interventions work best.[14] These recommendations include a greater consideration of theory to elucidate causal pathways linking social support to smoking outcomes and several methodological improvements, such as better differentiation of support concepts (e.g., perceptions of available support, objective indices of received support, smoking-cessation specific support), study designs that allow for multiple measurements of purported mediating mechanisms, and consideration of potential moderating factors in the link between social support and quitting success.[14,15]

One frequently purported model linking support to cessation is the stress-buffering model of social support. This model posits that social support helps smokers to quit and maintain abstinence by helping them to evaluate and deal more effectively with the stressors associated with quitting smoking.[2,16,17] Cessation attempts often increase stress levels for smokers,[18] as smoking abstinence causes withdrawal symptoms, including negative affect, which increase the likelihood of smoking relapse.[19–21] Theoretically, the ability to cope better with these cessation-related stressors, such as withdrawal symptoms, should increase the ability to abstain from smoking. Stress-buffering social support, then, is thought to facilitate quitting and maintenance of cessation by helping to regulate or "buffer" against the stress and negative affectivity associated with cessation attempts.[22] Surprisingly, though, there is scant evidence for this hypothesized pathway of the stress-buffering model. Even social support interventions deemed to be effective (e.g., quitlines) have often not included assessments of potential mediators,[14] making it impossible to determine how support facilitated quitting. To test the stress-buffering model of social support and determine whether the underlying mechanism linking social support to smoking cessation is reduced stress/negative affectivity, studies must include repeated assessments of withdrawal-related negative affect in addition to smoking-related outcomes.

In addition to asking more refined questions about how social support works, it is also important to determine for whom it works best. Understanding who is most likely to benefit from social support will help tailor supportive interventions to individual needs and may improve the effectiveness of such treatments.[14] Personality is one factor that may moderate the stress-buffering effects of social support for smokers. For example, individuals higher in trait negative affectivity or neuroticism might gain more advantages from stress-buffering support than individuals lower in negative affectivity or neuroticism. Indeed, one study found that smokers with higher pretreatment negative affectivity benefited more from support counseling, while those with lower pretreatment negative affectivity benefited more from skills training.[23] Given the importance of negative affectivity with both the beneficial effects of social support and the prediction of smoking relapse,[19] we sought to test a moderated mediation model of stress-buffering, such that individuals high in negative affectivity would show the greatest stress-buffering effects of social support.

Specifically, in the current study, we aimed to test the stress-buffering model of social support by examining negative affect-related mediators linking social support to cessation outcomes in

349 women enrolled in a smoking cessation program who were followed-up for 12 months post treatment. Consistent with prior studies, we hypothesized that social support would be negatively associated with risk of relapse and that this effect would be mediated by reduced withdrawal symptoms, including negative affect and depressive symptoms over time. Finally, we predicted that the personality trait of neuroticism, or negative affectivity,[24] would moderate this effect (i.e., moderated mediation[25]), such that individuals high in negative affectivity would show the greatest stress-buffering effects of social support. Because of evidence that perceived availability of social support, rather than mere membership in a social group or number of social contacts, is the critical determinant of stress buffering,[1,9,17] we measured perceptions of available support in the current study.

Methods

Participants and Design

We conducted secondary analyses using data from a randomized, double-blind, placebo-controlled trial conducted at Western Psychiatric Institute and Clinic, University of Pittsburgh Medical School between September 1999 and October 2005. Details of the study and main results have been previously published.[26] The University of Pittsburgh Institutional Review Board approved the protocol prior to recruitment. Two experimental manipulations (counseling [i.e., weight concerns vs. standard treatment] and medication [i.e., bupropion vs. placebo]) created four experimental conditions to which participants were randomized: weight concerns + bupropion ($N = 106$), weight concerns + placebo ($N = 87$), standard cessation counseling + bupropion ($N = 89$), and standard cessation counseling + placebo ($N = 67$).

Participants were 349 female smokers between the ages of 18 and 65 years who were motivated to quit smoking, smoked a minimum of 10 cigarettes per day, and endorsed concern about post-cessation weight gain. Women were recruited using posters, advertisements, and mailings. Exclusion criteria included current major depressive disorder or suicidality, drug or alcohol dependence within the past year, psychotic disorders as well as conditions associated with a lowered seizure threshold, the use of medications contraindicated with bupropion, uncontrolled hypertension, use of bupropion with the past year for more than one week, pregnancy or intention to become pregnant within the next year, and current use of other smoking or weight loss treatments. As reported previously,[26] there were no baseline differences in participant characteristics (i.e., age, education, race, weight, body mass index, cigarettes per day, and nicotine dependence) across the four treatment conditions.

Counseling and Study Medication

Counseling involved 12, 90-min group sessions delivered over three months, by clinicians with Masters degrees, trained to adherence on a treatment manual. All participants received cessation counseling focused on preparing to quit, the benefits of cessation, coping with smoking urges, and relapse prevention. The weight concerns and standard treatment interventions differed only in the additional content related to weight concerns. Specifically, the concerns intervention sought to reduce concerns about post-cessation weight gain to promote smoking cessation. This therapy focused on restructuring thoughts about food, eating, and weight and reevaluating beliefs

about the importance of a low weight and ideal shape. Sessions included education about cessation-related weight gain, the benefits of cessation relative to modest weight gain, and the disadvantages of trying to diet while quitting. The standard intervention did not directly address weight concerns. During these sessions, women were encouraged to discuss aspects of smoking cessation that related to their social situations (see ref.[26] for additional details).

Study medication was initiated at the second treatment session and a target quit day (TQD) was set for 10–14 days later. Bupropion hydrochloride sustained release (150 mg), supplied by GlaxoSmithKline, or placebo was administered once daily for the first 2 days and twice daily for the remainder of the 26-week treatment.

Measures

Demographic information, smoking history, nicotine dependence, personality measures, and social support were collected prior to randomization. Assessments of smoking (i.e., biochemically-verified prolonged abstinence), withdrawal symptoms, and depression were assessed for three weeks before the TQD and at months 1, 3, 6, and 12 post TQD.

Nicotine Dependence

Nicotine dependence was assessed by the Fagerström Test for Nicotine Dependence (FTND).[27]

Social Support

Perceived availability of social support was assessed by the Interpersonal Support Evaluation List (ISEL),[28] which measures perceived availability of supportive functions across four specific domains: appraisal support (perceived availability of having someone to talk to about one's problems), belonging support (perceived availability of people with whom one can do things), tangible support (perceived availability of material aid), and self-esteem (perceived availability of a positive comparison when comparing one's self to others). The ISEL has excellent internal reliability, test-retest reliability, and construct validity.[17,29] Analyses focused on the ISEL total score, as well as the four domain scores.

Neuroticism

Neuroticism was assessed by the six Neuroticism facets (anxiety, hostility, depression, self-consciousness, impulsiveness, vulnerability to stress) of the NEO Five Factor Inventory (NEO-FFI).[30]

Smoking Abstinence

At each assessment, women were interviewed about smoking using the time-line follow-back method, which covered the interval since the last completed assessment.[31] In addition, expired-air carbon monoxide (CO) was collected using a Vitalograph BreathCO monitor (Vitalograph Inc) and salivary samples were collected to assess cotinine levels. A CO reading of 8 ppm or less and a cotinine level of less than 15 µg/L were used to confirm nonsmoking.[32] Relapse was defined as the self-report of smoking for seven consecutive days at any point after the TQD or any biochemical indication of smoking.[33] Smoking for less than 7 days consecutively was not considered to be a relapse unless biochemical markers indicated smoking. Women who dropped out of treatment were considered to have relapsed as of the day following the last visit on which abstinence was verified. In cases when CO or cotinine measurement did not confirm abstinence or were not available, women were coded as having relapsed.

Withdrawal Symptoms

Withdrawal symptoms were assessed using visual analog scales ranging from 0 ("not at all") to 100 ("severe") for the following 12 symptoms of DSM-IV defined tobacco withdrawal: urge for cigarette, irritable/angry, anxious/tense, difficulty concentrating, restless, impatient, excessive hunger, depression, drowsiness, headache, stomach problems, insomnia. Participants were asked to rate how much they were experiencing each symptom "today." A composite score was calculated by taking an average of the 12 symptoms (Cronbach's alpha = .72). A pre-cessation baseline score was created by averaging scores from the three visits prior to TQD.

Depression Symptoms

The Beck Depression Inventory (BDI)[34] was used to assess depressive symptoms during the previous week, and the total score from the three visits prior to TQD were averaged to create a pre-cessation baseline.

Statistical Analyses

A Cox model was used to examine the relationships between social support and risk of relapse, controlling for randomization groups, FTND, and race (race was entered as a covariate because prior work revealed racial differences in perceived social support as assessed by the ISEL; e.g., ref.[35]). To examine the relationship between social support and withdrawal, mixed-effect models were applied to withdrawal symptoms from subjects who were abstinent at subsequent assessment points (1, 3, 6, 12 months), with a random subject-specific term and fixed terms of social support, pre-quit withdrawal symptoms, randomization groups, number of cigarettes smoked per day, and time. Withdrawal was then entered into the Cox model as a time-varying covariate, along with social support, randomization groups, nicotine dependence, race, and number of cigarettes per day, to examine whether the effect of social support on relapse time was mediated by reduced withdrawal symptoms over time. These mediation analyses were then run separately for depressive symptoms. Finally, to determine whether individuals high in trait negative affectivity (neuroticism) would show the greatest stress-buffering effects of social support (i.e., moderated mediation), a mixed-effect and/or a Cox model was used to determine whether the indirect effect of social support on withdrawal symptoms depended on neuroticism level and/or whether the effect of withdrawal on relapse depended on neuroticism level.[25] We controlled for randomization groups and other significant covariates in these final analyses, as well. Because study hypotheses focused on examining the relationship between social support and risk of relapse, we excluded 34 participants who did not initiate a cessation attempt (i.e., those who never stopped smoking) from all analyses. Omission of these participants resulted in better model fit indices (as assessed by a goodness-of-fit test for the proportional hazard (PH) assumption needed for Cox models[36]). Results were unchanged, however, when including these 34 participants in analyses.

Results

Table 1 shows baseline participant characteristics for the total sample. As shown, participants had a mean age of 42.0 (*SD* = 10.1) years, and the majority of the sample (86%) reported their ethnicity

as Caucasian. Participants reported smoking an average of 20.7 (SD = 8.4) cigarettes per day and scored an average of 5.2 (SD = 2.2) on the FTND. Table 2 displays withdrawal symptoms and depression scores across assessment sessions for participants who remained abstinent.

Abstinence and Time to Relapse

Of the 349 women at baseline, 31.8%, 21.8%, and 16.3% met criteria for prolonged abstinence at 3, 6, and 12 months, respectively. The median time to relapse was 13 weeks. As reported previously, abstinence rates and time to relapse were significantly improved for women receiving both bupropion and weight concerns counseling.[26]

Steps to Test the Stress-Buffering Model of Social Support

Step 1: Social Support as a Predictor of Risk of Relapse

As predicted, after controlling for random assignment to bupropion versus placebo and enhanced counseling versus standard treatment conditions, FTND level, and race, the ISEL total score was negatively related to risk of relapse in a survival model, χ^2(df = 1) = 6.63, p = .01, as were the subscales of tangible, χ^2(df = 1) = 9.46, p = .002, and belonging support, χ^2(df = 1) = 8.04, p = .005.

Step 2: Social Support as a Predictor of Withdrawal Symptoms and Depression Over Time

After controlling for covariates, the ISEL total score was negatively related to withdrawal symptoms over time in mixed effects models, F(1, 94) = 5.08, p = .03, as were the ISEL subscales of appraisal, F(1, 94) = 6.15, p = .01, self-esteem, F(1, 87) = 7.77, p = .007, and belonging support, F(1, 94) = 3.83, p = .05. The ISEL total score was also negatively related to depressive symptoms over time in mixed-effects models, F(1, 83) = 11.39, p = .001, as were the ISEL subscales of appraisal, F(1, 87) = 14.21, p < .001, and belonging support, F(1, 78) = 12.94, p < .001.

Table 1. Baseline Participant Characteristics for Total Sample

Characteristic	Mean (SD)/percentage
Age	42.0 (10.1)
Education, % college graduate	33
White, %	86
Cigarettes per day	20.7 (8.4)
Nicotine dependence, scale 0–10	5.2 (2.2)
Previous quit attempts	3.1 (2.6)
Withdrawal symptoms[a]	17.3 (10.8)
ISEL-Total	92.83 (15.8)
ISEL-Appraisal	24.18 (5.43)
ISEL-Belonging	23.82 (5.1)
ISEL-Tangible	23.21 (3.69)
ISEL-Self esteem	21.62 (4.24)
Depression symptoms (BDI)[a]	7.3 (6.6)
Neuroticism	19.54 (7.8)

Note. BDI = Beck Depression Inventory, ISEL = Interpersonal Support Evaluation List.

[a]A total score from the three visits prior to TQD were averaged to create a pre-cessation withdrawal symptoms baseline mean.

Step 3: Mediation: Is the Relationship between Social Support and Risk of Relapse Mediated by Reductions in Withdrawal Symptoms and Depression Over Time?

As hypothesized, a temporal mediation model showed that the effects of the ISEL total score, as well as the subscale of belonging support, on time to relapse were partially mediated by reductions in withdrawal symptoms over time (see Figure 1). Only the ISEL total score and the subscale of belonging support were considered here, as they were the only two social support variables that were significant in both step 1 and step 2 above. Contrary to predictions, depression symptoms did not mediate the relationship between social support and time to relapse.

Moderated Mediation: Do Individuals High in Trait Negative Affectivity Show the Greatest Stress-Buffering Effects of Social Support?

The ISEL total score and the subscale of belonging support were considered in the moderated mediation analyses, as these were the two variables that were associated with both risk of relapse and withdrawal symptoms. Contrary to predictions, the effect of social support total score on withdrawal did not depend on neuroticism level, F (1, 233) = .01, p = .93, nor did the effect of withdrawal on relapse depend on neuroticism level, χ^2(df = 1) = .67, p = .41. Similarly, the effect of belonging social support on withdrawal did not interact with neuroticism level, F(1, 233) = .27, p = .61, nor did the mediational effect of withdrawal depend on neuroticism level, χ^2(df = 1) = .05, p = .83.

Discussion

Social support is an important predictor of smoking cessation success, but the mechanisms by which social support affects cessation are not well understood.[14] The current study revealed a stress-buffering effect of social support, in which perceived social support protected or "buffered" individuals from withdrawal symptoms related to quitting smoking. Specifically, we found that increased social support predicted both reduced severity of withdrawal symptoms over time and a longer time to relapse in women enrolled in a smoking cessation trial. Importantly, to our knowledge, this study is the first to show that the effect of naturally occurring social support on risk of relapse was partially mediated by reductions in withdrawal symptoms over time. Results suggest that increased social support may buffer women from the harmful effects of cessation-related withdrawal symptoms, which in turn may relate to cessation success. These findings are consistent with the stress-buffering model, which states that social support helps smokers to quit and maintain abstinence by helping them to evaluate and deal more effectively with the stress associated with quitting smoking.[2,16,17]

Contrary to predictions, we did not find evidence of mediation by reduced symptoms of depression as assessed by the BDI, suggesting that social support may protect women from stress/negative affectivity related to withdrawal symptoms specifically, rather than depressive symptoms more generally. However, women with current major depressive disorder were excluded from this study, and participants did not report many depressive symptoms (mean BDI scores fell well within the "minimal depression" cutoff at baseline and all follow-up sessions). Thus, this null result may be due to an overall low level of depression symptomatology in this sample. Future studies should examine this

Table 2. Withdrawal Symptoms and Depression Over Time for Participants Who Remained Abstinent

Time	Withdrawal symptoms			BDI score		
	N	M	SD	N	M	SD
Baseline	347	17.3	10.8	322	7.3	6.6
Month 1	102	10.2	7.4	97	3.9	4.3
Month 3	74	6.7	6.9	60	3.9	4.7
Month 6	54	6.5	6.0	55	3.4	4.3
Month 12	46	3.8	5.5	44	3.6	5.0

Note. BDI = Beck Depression Inventory. Sample sizes at baseline are less than 349 due to missing participant data on these two questionnaires.
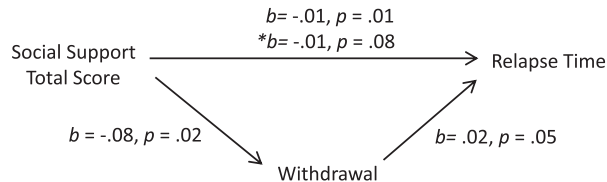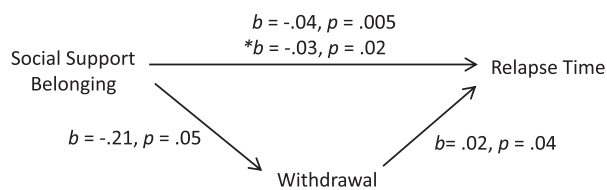
Figure 1. Reductions in withdrawal-related negative affect over time mediates the relationship between social support and risk of relapse.

question in samples expected to have higher and more variable BDI scores (e.g., in individuals with concurrent depressive symptomatology). Similarly, we did not find evidence of moderated mediation by neuroticism level. This finding is in contrast to a previous study that showed that individuals with higher trait negative affectivity benefited more from support counseling than those with lower negative affectivity,[23] and it suggests that individuals with varying levels of trait negative affectivity may benefit equally from naturally occurring social support during smoking cessation.

The current study addresses many of the noted shortcomings in previous research examining the role of social support in smoking cessation.[11,13] Specifically, strengths include a large sample size and a longitudinal design with repeated assessments of purported underlying mechanisms linking social support to risk of smoking relapse, as well as measurement of a suggested personality moderator. There are also important limitations, including the fact that only women with cessation-related weight gain concerns participated in this study. Findings should be replicated in more representative samples to ensure the generalizability of our results. The use of bupropion medication and the intensive nature of the smoking-cessation therapy are also limitations. It is important to note that results may have differed with the use of other (or the absence of) medications. Further, the intensive nature of the therapy offered in this trial may have provided additional smoking-specific social support that may have masked or blunted the effects of naturally

occurring social support on smoking cessation assessed in this study cessation. Although we measured multiple dimensions of social support, the ISEL is a self-report instrument, and thus item endorsement reflects participants' perceptions of support availability. Future studies should examine actual (i.e., received) social support. Finally, participants were asked to recall their smoking behavior using a timeline follow back method that covered the interval from the last assessment (i.e., 2–6 months), and future studies should include more frequent assessments to limit potential recall biases. To our knowledge, though, this study offers the first test of the stress-buffering theoretical model of social support and reveals a specific pathway by which naturally occurring social support facilitates smoking cessation (i.e., by mitigating bothersome withdrawal symptoms). These results may help to guide the design of interventions aimed at improving social support to facilitate smoking cessation.

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Declaration of Interests

None declared.

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