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Pilot Feasibility Trial of Dual Contingency Management for Cigarette Smoking Cessation and Weight Maintenance Among Weight-Concerned Female Smokers

Erika Litvin Bloom, PhD^{1,2}, Laura Hunt², Jennifer Tidey, PhD³, Susan E. Ramsey, PhD^{1,2}

¹Alpert Medical School of Brown University

²Rhode Island Hospital

³Brown University School of Public Health

Abstract

Many women who smoke cigarettes report that concern about weight gain is a barrier to quitting. Indeed, most quitters gain weight and some attribute relapses to weight gain concern. Contingency management (CM), which refers to reinforcing a target behavior with financial incentives, has been demonstrated effective for promoting smoking abstinence and weight management independently. We conducted a pilot trial to establish the feasibility of dual CM, in which both smoking cessation and weight maintenance were incentivized, as a smoking cessation intervention for female weight-concerned smokers. Participants (N = 10) received a 12-week intervention during which they earned financial incentives for smoking abstinence, verified by breath carbon monoxide (CO) testing, and for maintaining their weight (larger incentives for less than five pound gain, smaller incentives for 5–10 pound gain) while abstaining from smoking. They attended an end of intervention visit at week 13 and a follow-up visit at week 26. Total compensation was up to \$550 (\$255 for participation independent of smoking and weight, \$145 for smoking abstinence incentives, and \$150 for weight maintenance incentives). Results indicated that five of the 10 participants (50%) were continuously abstinent for at least 4 weeks and received at least two weight maintenance incentives. Three participants (33%) were abstinent at every visit they attended from quit date through week 26; two of these three had gained more than 10 pounds by week 26. Additional formative research to test alternative incentive schedules and modalities should be conducted before CM-W is evaluated in a larger trial.

Keywords

smoking; tobacco; smoking cessation; weight gain; contingency management; financial incentives

Corresponding Author: Erika Litvin Bloom, PhD, Behavioral/Social Scientist, RAND Corporation, 20 Park Plaza #920, Boston, MA 02116, Phone: (617) 338-2059 x8616, erika_bloom@brown.edu.

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DISCLOSURES

In 2017, Dr. Bloom was a consultant for WayBetter, Inc., a company that develops digital contingency management programs, to assist with development of a smoking cessation program that is unrelated to the research described in this manuscript. The other authors declare that they have no conflicts of interest to report.

INTRODUCTION

Women are more likely than men to smoke cigarettes for weight control (Pinto et al., 1999; Weekley, Klesges, & Reylea, 1992; White, McKee, & O'Malley S, 2007) and to be concerned about gaining weight after quitting (Clark et al., 2006; Pomerleau, Zucker, & Stewart, 2001). Weight concern is associated with smoking cessation treatment drop-out and relapse (Brouwer & Pomerleau, 2000; Clark et al., 2006; Copeland, Martin, Geiselman, Rash, & Kendzor, 2006; Jeffery, Hennrikus, Lando, Murray, & Liu, 2000; Meyers et al., 1997; Mizes et al., 1998). Indeed, 80% of quitters gain weight (Aubin, Farley, Lycett, Lahmek, & Aveyard, 2012). Most weight gain occurs during the first 6–12 months after smoking cessation; the mean gain was six pounds at 3 months, nine pounds at 6 months, and 10 pounds at 12 months (Aubin et al., 2012). Women gain significantly more weight than men, with an estimated 13–27% of women gaining > 25 pounds or a 12–20% increase from their pre-quit weight (Nides et al., 1994; O'Hara et al., 1998; Williamson et al., 1991). Furthermore, most female smokers report that they are unwilling to gain more than five pounds (Levine, Perkins, & Marcus, 2001; Pomerleau & Kurth, 1996).

Weight gain after quitting smoking is associated with increased caloric intake that cannot be entirely explained by the reversal of nicotine's pharmacological effects (Audrain-McGovern & Benowitz, 2011; Filozof, Fernandez Pinilla, & Fernandez-Cruz, 2004; Hudmon, Gritz, Clayton, & Nisenbaum, 1999). None of the FDA-approved smoking cessation medications have been shown to have significant long-term effects on weight gain (Aubin et al., 2012). A number of adjunctive behavioral interventions targeting weight gain concern in smoking cessation have been tested previously including behavioral weight control treatment (e.g., Bush et al., 2018; Johnson et al., 2017; Spring et al., 2004), aerobic exercise (e.g., Marcus et al., 1999; Marcus et al., 2005; Prapavessis et al., 2007; Prochaska et al., 2008; Williams et al., 2010), cognitive-behavioral therapy (CBT) (Levine et al., 2010; Perkins et al., 2001), and, most recently, acceptance and commitment therapy (ACT) (Bloom et al., 2017; Bloom et al., March 2016). The explicit goal of the CBT and ACT interventions was to reduce the degree to which distress about anticipated or actual weight concern was a barrier to quitting rather than to reduce weight gain per se. Reviews indicate no significant impact on long-term smoking or weight outcomes (Farley, Hajek, Lycett, & Aveyard, 2012; Parsons, Shraim, Inglis, Aveyard, & Hajek, 2009; Spring et al., 2009).

Contingency management (CM) interventions involve providing external reinforcement (e.g., financial incentives) for behavior change. CM is effective at promoting short-term smoking cessation (Sigmon & Patrick, 2012) and weight management (Jeffery, 2012) independently, but has never been used to help smokers minimize weight gain in the context of smoking cessation. In this study, we conducted a pilot trial of a 12-week contingency management intervention with dual contingencies that targeted smoking cessation and weight maintenance (CM-W). Female smokers who reported gaining at least 10 pounds during a past quit attempt received financial incentives for quitting smoking and for limiting their weight gain (i.e., weight maintenance) while remaining abstinent from smoking. Because we considered weight maintenance to be secondary to the smoking cessation goal, all weight maintenance incentives were delivered contingent upon at least two weeks of continuous smoking abstinence, verified by breath carbon monoxide (CO). Participants were

also referred to a quitline for counseling and received nicotine replacement therapy (NRT). Our goal was to establish initial feasibility for CM-W; that is, to demonstrate that this dual contingency did not appear to hinder the primary outcome of smoking cessation and was acceptable to participants (i.e., they would not report negative reactions). Based on the results of a recent community-based CM study in which participants received counseling and NRT (Secades-Villa, Garcia-Rodriguez, Lopez-Nunez, Alonso-Perez, & Fernandez-Hermida, 2014), we estimated that 75% of participants would achieve at least two weeks of abstinence and therefore have the opportunity to earn a weight maintenance incentive.

METHOD

Participants and Procedure

We aimed to recruit women who would be at high-risk for not initiating a quit attempt or for relapsing due to weight concern. Participants (N = 10) were recruited through paper and electronic advertisements that targeted women who wanted to quit smoking and had gained unwanted weight during a past quit attempt. Eligible women were at least 18 years old, smoked at least five cigarettes per day, had a body mass index (BMI) of at least 18.5, were concerned about gaining weight after quitting (at least 50 on at least one of two 100 point scales: “How concerned are you about gaining weight after quitting smoking?” and “How concerned would you be if quitting smoking caused you to permanently gain 10–15 pounds?”) (Levine et al., 2010; Perkins et al., 2001), and reported gaining at least 10 pounds during a past quit attempt. Exclusion criteria were current use of smoking cessation (e.g., bupropion) or weight loss treatments; use of other combustible products (e.g., marijuana) at least weekly; current self-reported substance use disorder (SUD) other than tobacco or score of ≥ 2 on the CAGE-AID (Brown, Leonard, Saunders, & Papasouliotis, 1998; Brown & Rounds, 1995); lifetime self-reported bipolar disorder, psychotic disorder, or eating disorder, or endorsed eating disordered behavior on the Eating Attitudes Test (EAT-26, Garner, Olmsted, Bohr, & Garfinkel, 1982); score of ≥ 20 indicating severe depressive symptoms or endorsed suicidal ideation on the Patient Health Questionnaire-9 (PHQ-9, Kroenke, Spitzer, & Williams, 2001); or pregnancy/breastfeeding/other medical contraindication for the use of nicotine patches. After the first participant was enrolled, we added self-reported COPD, asthma, and lactose intolerance as additional exclusion criteria because of evidence suggesting that these conditions might affect breath CO levels (McNeill, Owen, Belcher, Sutherland, & Fleming, 1990; Sato et al., 2003).

Interested women who met preliminary eligibility criteria during a telephone screening were scheduled for a 60-min baseline assessment at Rhode Island Hospital (RIH) at which written informed consent was obtained and additional screening (CAGE-AID, EAT-26, PHQ-9) was administered to confirm eligibility. At the end of the baseline assessment, participants selected a target quit date on a Monday within the next month, which was their first day of CM-W. CM-W lasted 12 weeks and consisted of 24 15-min visits: daily (Monday-Friday) during the first week, twice weekly during weeks two through nine (visits at least two days apart), and once weekly during weeks 10–12. Participants attended a 30-min end-of-intervention visit at week 13 and a 30-min follow-up visit at week 26. All visits at which participants were weighed (see below) occurred at RIH. Other visits occurred at RIH or a

convenient public location of the participant's choice. This study was approved by the Institutional Review Board at Lifespan (parent corporation of RIH).

A total of 31 women were screened, of whom 19 met preliminary eligibility criteria and scheduled a baseline assessment, 14 attended and 13 completed the baseline (one was determined ineligible during baseline), and 10 initiated CM-W. Reasons for ineligibility included: no previous quit attempts or did not gain at least 10 pounds in a previous quit attempt (three), nicotine patch contraindication (three), bupropion use (two), and one each: unable to travel to the study site, smoked fewer than 5 cigarettes per day, current SUD, COPD, and marijuana use. The three who were eligible but did not initiate CM-W dropped out due to schedule conflicts or loss of interest. The proportions who met eligibility criteria and initiated the intervention were similar to or higher than in other recent, larger smoking cessation trials conducted by our team and colleagues (Bloom, Farris, DiBello, & Abrantes, 2019; Bloom et al., March 2016; Brown et al., 2018).

Assessments

Baseline measures included additional screening to confirm eligibility, demographics, BMI calculated from self-reported height and weight measured using a calibrated medical scale, and tobacco use and weight history, including The Fagerström Test for Nicotine Dependence (FTND; Heatherton, Kozlowski, Frecker, & Fagerström, 1991).

Smoking Behavior Outcomes.—At every visit, participants reported on their tobacco use since their previous visit (at baseline, past 14 days) using the timeline followback method (R. A. Brown et al., 1998) and provided a breath sample for measurement of expired carbon monoxide (CO). Smoking abstinence was defined as self-reported abstinence from combusted tobacco since the previous visit and CO $\leq$ 6 parts per million (ppm), with the exception of the quit date (first day of CM-W), on which abstinence was defined as self-reported abstinence from combusted tobacco since the previous evening and CO of 50% less than baseline or $\leq$ 6 ppm, whichever was higher.

Weight Outcomes.—All participants were weighed on a calibrated medical scale at baseline, quit date (first day of CM-W), week 5 day 1, week 9 day 1, week 13, and week 26. Participants were also weighed at other visits whenever they were eligible to receive a weight maintenance incentive. All weight maintenance incentives during CM-W were based on weight change since quit date. We encouraged participants to wear similar clothing on weight assessment days.

CM-W Intervention Components

Quitline counseling and weight management resources.—At the end of the baseline assessment, participants were advised to contact their local state quitline to receive free telephone counseling. They were also provided with a list of online weight management resources (e.g., www.choosemyplate.gov).

Nicotine patches.—Participants received an 8-week course of over-the-counter nicotine patches at no cost, dosed according to label instructions. They were instructed to begin wearing the patch on their quit date.

Incentives for participation.—All participants received a cash incentive for participation at every visit, independent of smoking and weight (see Figure 1). They received a bonus of \$20 at week 5 day 1 if they attended all visits from weeks 1–4 and another bonus of \$20 at week 26 if they attended all visits from weeks 5–13. The maximum compensation for participation was \$255.

Incentives for smoking abstinence.—Participants received a cash incentive for smoking abstinence, independent of weight, at every visit during the first 4 weeks. The incentive was \$5 on quit date and increased by \$1 for each consecutive abstinent visit with a \$5 bonus for every third consecutive abstinent visit, for maximum potential earnings of \$145 by week 5 day 1 (see Figure 1). After a non-abstinent or missed visit, the available incentive for the next visit reset to \$5. However, after two consecutive abstinent visits, the available incentive for the next visit returned to the pre-reset level. This incentive schedule was modeled on previous research (Roll, Higgins, & Badger, 1996).

Incentives for weight maintenance.—We did not expect participants to gain any weight if they continued smoking. Also, we did not want to create an incentive for participants to continue smoking to obtain weight maintenance incentives. Therefore, all weight maintenance incentives were delivered contingent upon at least two weeks of smoking abstinence. We defined weight gain of less than five pounds as “weight maintenance”, for which the highest value incentives would be provided, because most female smokers report that they will tolerate a maximum gain of five pounds (Levine et al., 2001; Pomerleau & Kurth, 1996) and also because we wanted to accommodate expected weight fluctuations due to factors that would vary by weight assessment, including menstrual cycle phase, clothing styles, and time of day. We provided lower value incentives for weight gain of five to 10 pounds because 10 pounds is the mean weight gain at three to six months after quitting (Aubin et al., 2012). No incentives were provided for gains over 10 pounds.

Participants earned their first weight maintenance cash incentive (\$20) after two weeks of continuous smoking abstinence if they had gained less than five pounds since quit date. Therefore, the earliest that this incentive could be earned was at week 3 day 1 assuming the participant did not have any lapses since quit date. Additional weight maintenance incentives were available after 4, 8, and 12 weeks of continuous abstinence. For these latter incentives, participants received a higher incentive (\$30, \$40, \$60, respectively) if they had gained less than five pounds and a lower incentive (\$5, \$20, \$30, respectively) if they had gained five to 10 pounds (see Figure 1). The maximum amount that could be earned for weight maintenance was \$150. As with the abstinence incentives, weight maintenance incentives reset after a non-abstinent or missed visit (i.e., participant had to quit again for two weeks to receive the first \$20 weight maintenance incentive). However, weight maintenance incentives withheld due to excess weight gain did not reset if abstinence was maintained. For example, if a participant who was maintaining abstinence gained less than 10 pounds by

week 9 day 1, she would not receive the \$40 incentive, but, if by week 13 her weight gain had dropped to less than five pounds, she would receive the \$60 incentive.

The maximum possible total compensation (participation plus incentives for abstinence and weight maintenance) was \$550, which was consistent with other recent CM studies (e.g., Dallery et al., 2017; Secades-Villa et al., 2014)

RESULTS

Participant characteristics are shown in Table 1. Six of the 10 participants who initiated CM-W were retained through week 26. Nine participants used at least one nicotine patch, and five contacted the quitline, of whom two received at least one counseling session. Individual participant outcomes (arranged from most to least abstinent visits) are shown in Figure 1.

Five participants never achieved two weeks of continuous abstinence and therefore did not earn any weight maintenance incentives. Three of these five were retained through the 26-week follow-up; their weight gain at week 26 was two, eight, and nine pounds respectively. One, who was the first enrolled, dropped out during week 3 due to a misunderstanding of the criteria for obtaining abstinence incentives. We subsequently revised participant instructions to improve clarity and there were no further misunderstandings or negative reactions. Another participant dropped out during week 2 for unknown reasons (lost contact).

Five participants were continuously abstinent for at least four weeks and earned at least 11 out of a possible 12 abstinence incentives and at least two out of a possible four weight maintenance incentives. Among these five, three were abstinent at week 13 and maintained continuous abstinence through week 26. They had all gained less than 10 pounds by week 13, but by week 26, two had gained more than 10 pounds (15 and 16 pounds, respectively) while the third had lost weight since week 13 and was two pounds under quit date. One dropped out during week 5 for unknown reasons (lost contact), having gained 1 pound. The other chose to drop out during week 9 due to relapse she attributed to personal factors. Her weight gain at time of drop out was 11 pounds.

DISCUSSION

We conducted the first study to apply contingency management (CM) for smoking abstinence with a secondary aim of weight maintenance (CM-W). Among the 10 female weight-concerned smokers who participated, five (50%), vs. the 75% hypothesized, maintained continuous abstinence for at least two weeks and therefore had the opportunity to earn a weight maintenance incentive. Our 75% estimate was based on a previous CM study in which all participants received counseling (Secades-Villa et al., 2014), whereas in this study most participants did not receive counseling. However, the study by Secades-Villa et al. was not restricted to women nor had inclusion criteria related to weight concern. These factors may have contributed to the lower 2-week abstinence rate in the current study. Nevertheless, we do not believe that the dual contingency hindered smoking cessation given that all five of these participants maintained continuous abstinence for at least four weeks and earned at least two of the four possible weight maintenance incentives, and three participants (33%) maintained continuous abstinence from the end of the 12-week

intervention through the 26-week follow-up. The past-week abstinence rate was 40% at 4 weeks post-quit and 23% at 6 months post-quit in a recent CM trial that did not include counseling or medication (Dallery et al., 2017).

A primary criticism of CM is that although it can be very effective in the short-term, high relapse rates are often observed upon withdrawal of the incentives (Cahill, Hartmann-Boyce, & Perera, 2015; Jeffery, 2012; Sigmon & Patrick, 2012). Petry (2010) insightfully argued that while this criticism is commonly directed at CM, it applies equally to other treatments for SUDs. Nevertheless, weight gain after smoking cessation is a novel, potentially ideal target for CM because it is a naturally time-limited phenomenon, such that weight gain occurs primarily during the first three to six months after quitting and then tapers off (Aubin et al., 2012). Therefore, given that most relapse also occurs within three months after quitting (Hughes, Keely, & Naud, 2004), we hypothesized that if weight maintenance incentives were available for three months, smoking relapse may be unlikely to occur after incentives are discontinued even if additional weight was gained and the total amount of weight gained in the long-term was not reduced. Indeed, none of the three participants who were abstinent at the end of CM-W had relapsed by the week 26 follow-up, even though two did gain additional weight such that their total weight gain exceeded 10 pounds.

Although a longer program may confer additional benefit with regard to minimizing long-term weight gain, ultimately the primary goal of CM-W is to increase long-term smoking abstinence. Furthermore, whereas women believe that weight gain will trigger relapse, study results are mixed (e.g., Borrelli & Mermelstein, 1998; Hall, Ginsberg, & Jones, 1986). Given that weight-concerned smokers have been more likely to drop out of treatment prior to quitting (Brouwer & Pomerleau, 2000; Copeland et al., 2006; Mizes et al., 1998), or may relapse before gaining significant weight, they may have been underrepresented in past analyses of the relationship between weight gain and relapse.

Future research should test alternative incentive schedules that may be easier to track or more effective at promoting smoking cessation. Participants could receive a small incentive with a constant value for smoking abstinence at every visit, independent of weight change. Weight maintenance incentives could be offered at every abstinent visit instead of only after two weeks of abstinence. Finally, incentives could be provided for limiting weight gain within a specified period (e.g., less than a pound gain since the previous week) instead of or in addition to total cumulative weight gain.

The primary limitations of this study were the small sample size and lack of a control group, which are characteristic of pilot feasibility trials. It is possible that long-term outcomes on both smoking and weight would have been the same with a CM intervention that targeted smoking cessation only. On the other hand, it is possible that some study participants may have been reluctant to initiate cessation if the intervention did not also include a weight maintenance goal. A third limitation is that it is possible participants could have smoked some cigarettes that went undetected because only past 24-hour smoking can be detected reliably with CO testing (SRNT Subcommittee on Biochemical Verification, 2002). We attempted to minimize this possibility by asking participants to self-report their smoking behavior prior to CO testing and withholding incentives if participants reported smoking.

Past week smoking can be detected reliably with urine or saliva cotinine (nicotine metabolite) testing (SRNT Subcommittee on Biochemical Verification, 2002). However, cotinine testing cannot be used if participants are using NRT or any other nicotine products, as they were in this study. A fourth limitation is that our procedures for assessing weight gain were less standardized than procedures typically used in weight loss trials, although we allowed up to a five pound gain to account for weight variations due to this lack of standardization. Given that most participants did gain some weight, we have no reason to believe that any participant engaged in potentially harmful behaviors to induce weight loss or attempted to misrepresent her baseline weight (e.g., by wearing heavy clothing). Additionally, CM-W did not include any counseling; rather, participants were referred to a quitline. Future research should examine methods to increase engagement in counseling. Finally, CM-W was time and resource-intensive, requiring 27 in-person visits and close attention from study staff to track participants' progress and calculate incentives. Therefore, although our CM-W was feasible in this academic research context, we acknowledge it is unlikely to be disseminable to most clinical settings. In addition to testing alternative incentive protocols as described above, future studies should also test whether CM-W could be delivered remotely (i.e., participants self-test at home and submit the result to the research team via the Internet), which would permit daily CO testing to be sustained for a longer period. CM delivered remotely has established acceptability and efficacy (Dallery & Raiff, 2011; Dallery et al., 2017) and may increase potential for dissemination.

In summary, we believe that this dual target CM represents a promising approach to promoting smoking cessation among weight-concerned female smokers. After additional formative research to examine alternative incentive schedules and program delivery modalities, a revised CM-W should be evaluated in a fully powered, randomized controlled trial (RCT).

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Public Health Significance:

Most people who stop smoking cigarettes gain weight. Fear of weight gain is a persistent barrier to smoking cessation, especially among women. This study established the feasibility of a novel contingency management intervention for smoking cessation and weight maintenance.

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Figure 1.
Individual participant outcomes for participation, smoking abstinence, and weight gain.

Table 1.

Baseline Participant Characteristics (N = 10)

	N or <i>M</i> (<i>SD</i>)
Age	46.2 (14.6)
White	6
Black	2
Native Hawaiian/Pacific Islander	1
More than one race	1
Hispanic	1
Education: high school or less	4
Employed	1 full-time, 5 part-time
Income < \$50,000	8
Cigarettes per day	13.1 (5.9)
FTND	4.6 (2.1)
Body Mass Index (BMI) on quit date	33.2 (8.3)