HHS Public Access

Author manuscript

Ann Behav Med. Author manuscript; available in PMC 2017 June 01.

Published in final edited form as:

Ann Behav Med. 2016 June ; 50(3): 460–470. doi:10.1007/s12160-016-9774-z.

Theoretical and Behavioral Mediators of a Weight Loss Intervention for Men

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Abstract

Objective—Men are currently underrepresented in weight loss trials despite similar obesity rates, which limits our understanding about the most effective elements of treatment for men. The purpose of this study was to test the theoretical (autonomous motivation, self-efficacy, outcome expectancies, and self-regulation) and behavioral (calorie intake, physical activity, self-weighing) mediators of a men-only, Internet-delivered weight loss intervention focused on innovative and tailored treatment elements specifically for men.

Method—Data come from a six-month randomized trial (N = 107) testing the intervention compared to a waitlist control group. Changes in the theoretical mediators between baseline and three months were tested as mediators of the intervention effect on weight change at six months in both single and multiple mediator models. Changes in behaviors between baseline and six months were tested in the same manner.

Results—The intervention produced greater weight losses compared to the control group (−5.57 kg ± 6.6 vs. −0.65 kg ± 3.3, $p < 0.001$) and significant changes (p's < 0.05) in most of the theoretical and behavior mediators. In multiple mediator models, changes in diet-related autonomous motivation, self-efficacy, and self-regulation all significantly mediated the relationship between the intervention and weight loss. The intervention effect was also mediated by changes in dietary intake and self-weighing frequency.

Conclusions—By testing the theoretical mediators of this intervention in a multiple mediator context, this study contributes to current knowledge related to the development of weight loss interventions for men and suggests that interventions should target diet-focused constructs.

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Conflict of Interest Statement

DFT receives personal fees as a scientific advisor for Weight Watchers International. All other authors declared no conflict of interest.

Keywords

Men; Mediators; Weight loss; Behavioral intervention

The prevalence of obesity among men has recently become equal to that among women for the first time in the United States (1, 2). Along with the rise in the prevalence of obesity in men, there has been growing attention to the fact that men are underrepresented in behavioral weight reduction programs where only 27% of participants are men (3). Once men enter a weight loss program, they typically lose as much weight as women (4, 5); however, the reach of these programs remains limited and it is unclear whether the men who take part in mixed-gender weight loss programs are representative of all men in need of weight loss assistance.

A small number of studies have been conducted to test weight loss programs developed specifically for men (6). Although these programs have generally been successful, few studies have been published that focus on the mechanisms through which the interventions produce weight loss. Of the studies that have been published, the focus has been on testing behaviors as mediators of the treatment effect. Potential mediators that have been considered are: physical activity (steps per day), total caloric intake, habitual portion size, and specific eating behaviors such as consumption of “take-away” meals, high-caloric-density snacks, sugar-sweetened beverages, and alcoholic beverages (7-9). These studies have found that steps taken per day is generally a mediator of the intervention effect on weight loss (7, 9), but this finding has not been consistent (8). Of the eating behaviors that have been tested, only portion size and take-away meals were significant mediators in one of the analyses (9). While these studies advance the understanding of how some behaviors may be mechanisms for weight loss among men, there is a need to understand which theoretical constructs should be targeted to produce changes in these behaviors.

Applying and testing theories is needed to help to advance the field of behavioral intervention development (10). Although all of the interventions that were included in the analyses described above were based on theory, there have been no studies of men-only weight loss interventions that have tested whether the interventions influenced the intended theoretical constructs and whether those theoretical constructs were related to behaviors and weight loss, thus more fully exploring the way in which the interventions may be producing weight loss.

Theoretical model of the REFIT intervention

In order to meet men’s needs for weight loss programs that are appealing and effective, the Rethinking Eating and FITness (REFIT) study was conducted (11). This intervention was developed to match men’s preferences for weight control while also incorporating evidenced based strategies and theoretically based intervention targets. The REFIT intervention was developed to target the theoretical constructs shown in the conceptual model (Figure 1). The conceptual model incorporates constructs from self-determination theory (SDT; 12) as well as social cognitive theory (SCT; 13, 14). The target constructs were included in the conceptual model because of their association with weight loss in prior studies of weight control. Higher levels of autonomous motivation for diet and exercise have been associated with both short and long-term weight loss (15, 16). Similarly, changes in self-efficacy (17-19) and self-regulation (20, 21) have also been associated with weight loss. Although these constructs have significant support for their association with weight loss, these studies have been conducted using samples comprised entirely or nearly entirely of women. Therefore it is important to test which of the constructs that have been associated with weight loss for women are also important intervention targets for men as well. The final construct in the conceptual model of the REFIT intervention is outcome expectancies. Although outcome expectancies have not generally been associated with weight loss (e.g., 17, 22) this construct was selected as an intervention target because of reports that men avoid weight loss programs due to concerns about the negative outcomes of making changes to their diet (e.g., 23, 24). Targeting ways to overcome these negative expectations was hypothesized to help men better implement the recommended changes.

The purpose of this study was to test the theoretical and behavioral mediators of the effect of the Rethinking Eating and FITness (REFIT) intervention on weight loss among men.

Methods

Data for this analysis come from a six-month randomized controlled trial testing the efficacy of the REFIT intervention (11). Briefly, the REFIT intervention encouraged participants to decrease their caloric intake by making a minimum of six 100-calorie changes each day from their baseline eating habits and to increase their energy expenditure by increasing their physical activity gradually up to 225 minutes of moderate-to-vigorous physical activity per week. Participants were encouraged to track the changes to their diet, along with their daily weight and minutes of activity to monitor their progress towards study and self-developed goals. In order to create a greater sense of autonomy in the structured program, participants chose which diet behaviors to focus on changing each week from multiple behavior targets that were presented. Brief lessons were provided that focused on how to make the selected behavior change. The REFIT intervention was delivered via two group sessions and 13 online contacts. The online contacts consisted of a participant receiving a link to an online survey where he was guided through a check-in process. During this process, the participant would report his current weight, the changes he made to his diet over the past week, his minutes of physical activity, and days that he weighed himself. Automated, tailored feedback was provided for each of these domains. After the participant received his feedback, he selected the next diet strategy he would focus on over the next week in order to reach the goal of making six 100-calorie changes per day. The treatment was delivered weekly for three months followed by monthly contact for three months.

The intervention components were developed to target the theoretical mediators of the intervention. Self-efficacy for diet and exercise were enhanced via gradually increasing exercise goals, encouraging participants to master one dietary change before changing another, goal setting, and positive reinforcement of goal attainment during tailored feedback. Autonomous motivation was enhanced through providing the choice of behaviors to change each week related to diet and physical activity, frequent encouragement to evaluate sources of motivation for changing weight loss behaviors, and use of nondirective language in lessons and in tailored feedback. Outcome expectations were targeted through providing descriptions of the expected outcome of each behavior change and how that change could be enacted in both lessons and tailored feedback, and pre-intervention self-evaluations to encourage participant's assessment of behaviors they wanted to make. Self-regulation was encouraged through daily self-monitoring of changes to diet, weight, and minutes of physical activity and through the weekly contacts where participants would report their self-monitoring results from the prior week.

Participants completed 11.2 (SD 2.7) of the 13 online contacts and reported making an average of 28 (SD 16) 100-calorie changes per week to their diet. Participants reported self-monitoring their behavior regularly using a mobile application (44.7%), using the study created self-monitoring form (23.4%), and through daily self-weighing (62.5%). Over 90% of randomized participants (N = 97) took part in the six-month assessment and 95.7% of participants who received the REFIT program reported that they would recommend it to a friend (11).

Assessments were conducted prior to randomization (baseline) and at three and six months post-randomization. Weight and all psychosocial constructs and behaviors were measured at each assessment. Participants were given $20 for completing the three and six-month assessments. All procedures were reviewed and approved by the institutional review board at the University of North Carolina.

Participants

Participants were recruited for this study via email listservs sent to the University of North Carolina community and to employees of a local county government and as well as via flyers distributed in the surrounding community. To be eligible, men needed to be 18-65 years old, have a BMI 25-40 kg/m^2, be healthy enough to exercise independently (25), be able to attend two face-to-face group sessions, and be able to access online intervention content. Men were excluded if they reported high levels of alcohol intake (> 10 on the Alcohol Use Disorder Identification Test; 26), had lost more than 10 pounds in the prior six months, or were currently being treated for cancer or a major psychiatric condition. Randomized participants (N=107) were an average age of 44.2 (± 11.4) years, obese (BMI 31.4 ± 3.9), predominately non-Hispanic white (76.6%), married (79.4%), and had at least a bachelor's degree (83.2%). There were no differences between the randomized groups on baseline characteristics (p's > 0.19).

Measures

Weight was measured twice (average used) at each assessment using a calibrated digital scale (Tanita Model: BWB-800s) to the nearest tenth of a kilogram. Participants were measured without shoes while wearing spandex compression-style shorts.

Diet-related measures—Autonomous motivation for eating a healthier diet was assessed using the Treatment Self-Regulation Questionnaire for diet (27). This 15-item questionnaire assesses motivations underlying a change to healthy eating or continued healthy eating on subscales of autonomous motivation ("I feel that I want to take responsibility for my own health”), controlled motivation, and amotivation. This scale demonstrated excellent internal consistency in the current sample (assessed at baseline, Cronbach’s alpha = 0.90). Self-efficacy for controlling eating was assessed using the Weight Efficacy Lifestyle Questionnaire (28). The 20-item measure assesses feelings of being able to control eating response to five types of situations (presence of negative emotions, food availability, social pressure, physical discomfort, and positive activities). A total score across the five domains was created (alpha = 0.95). Outcome expectancies for eating a healthy diet were assessed using the Health Beliefs Survey: Healthy Food Outcomes, developed by Anderson and colleagues (22). This 22-item scale assesses degree of agreement with statements of positive outcomes of eating healthier foods (“I will have more energy”) and negative outcomes (“The food I eat will not taste good”). Scores for positive and negative outcomes were developed (alpha = 0.89; 0.86, respectively). Finally, self-regulation of eating behaviors was assessed using the Eating Behavior Inventory (29). This 26-item index assesses frequency of using weight control strategies that promote self-regulation of eating behaviors (“I carefully watch the quantity of food that I eat.”). In the current sample, an internal reliability was low but acceptable (alpha = 0.61).

Exercise-related measures—Autonomous motivation for exercise was assessed using the Treatment Self-Regulation Questionnaire for exercise (27). This 15-item measure assesses motivations for exercising regularly, along the dimensions of autonomous motivation (“Because I personally believe it is the best thing for my health”; alpha = 0.92), controlled motivation, and amotivation. Self-efficacy for exercise was assessed using a scale developed by Sallis and colleagues (30). The measure uses 12 items to assess belief that one can exercise consistently (“Stick to your exercise program after a long, tiring day”) and can make time for exercise (“Get up early, even on weekends to exercise”). In the current sample, this measure demonstrated high internal consistency (alpha = 0.90). Outcome expectancies for exercising regularly were assessed using the Health Beliefs Survey: Physical Activity Beliefs scale, developed by Anderson and colleagues (22). This survey uses 27 items to assess agreement that the potential outcome would occur following a regular exercise routine and whether the outcome would affect the respondent’s decision to exercise. Outcomes were assessed for positive health outcomes (“I will sleep better”), positive affective outcomes (“I will feel less stressed”), and negative outcomes (“I will have less time to spend with my family”). Multiplying the ratings of agreement and relevance to the respondent created a score for each item. These were summed to create the three subscale scores. The subscales were all internally consistent (alpha’s = 0.77; 0.86; 0.88, respectively).

Behavior measures—Dietary intake was measured using the National Cancer Institute’s Automated Self-Administered 24-hour Recall (version 2011; ASA-24). Participants completed two recalls during each assessment: one each for a weekday and a weekend day. Recalls that were outside of a probable range for a single day intake for an adult man (i.e., 650-5,700 calories) were removed (Baseline: n = 2, 3M: n = 3, 6M: n = 0). Caloric expenditure through physical activity was measured using the Paffenbarger Activity Questionnaire (31), completed during a structured interview. This questionnaire assesses leisure time physical activity, walking for exercise and transportation, and daily flights of stairs climbed over the previous week. Caloric expenditure was estimated by classifying activities using the metabolic equivalents for each activity from the Compendium of Physical Activities (32). Self-weighing was assessed at each assessment using a single-item measure which asks how often the participant currently weighs himself on a seven-point scale from "never" to "multiple times per day." This measure has been used in prior studies (e.g., 21).

Statistical analysis

Changes in the theoretical constructs between baseline and three months were tested as mediators of the treatment effect on weight between baseline and six months (see Figure 2a). Similarly, changes in the theoretical constructs were also tested as mediators of the treatment effect on changes in calorie intake and calorie expenditure through physical activity between baseline and six months (see Figure 2b). These time points were selected in order to establish a temporal relationship between the delivery of the intervention, the change in the cognitive construct, and change in weight or the target behaviors as measured at the final assessment. Changes in the behaviors between baseline and six-months were also tested as mediators of the treatment on weight loss. Changes in behaviors between the baseline and six-month assessments were selected due to their proximity to the weight outcomes while they remained temporally prior to the final weight loss. Change scores for each mediator were calculated by regressing the later measure on the baseline measure. Weight change was calculated such that negative values indicated a weight loss between baseline and six months.

All analyses were conducted using SAS 9.3. The study was designed to detect a weight loss difference between groups at three and six months of 2.0 kg (SD 3.0 kg) with 80% power and allowing for up to 15% attrition (needed N = 104). Using data from the 97 participants who completed the six-month follow-up assessment, this analysis was powered to detect medium-to-large mediated effects using bias-corrected bootstrap procedure (33).

Differences between study groups at baseline and differences in assessment completion were assessed using independent-group t-tests and chi-square. Changes over time by within each treatment group were assessed using paired t-tests. Caloric expenditure via physical activity at each assessment was moderately positively skewed and was transformed using a square root transformation prior to analysis. Mediation effects were tested using the PROCESS macro developed by Hayes (34). This macro uses regression analysis to test the relationships between the independent variable and the mediator (the A-path), the relationship between the mediator and the outcome while controlling for the independent variable (B-path), and finally the indirect effect of the independent variable on the dependent variable through the mediator (a*b). The significance of the A-path and B-paths were assessed using normal-theory probability testing. Estimated coefficients, standard errors, and probability values are reported. To test the significance of the indirect effects, this macro develops 1000 bootstrapped samples of the indirect effect and reports the bootstrapped standard errors and 95% confidence interval around the mean estimated effect. This technique is superior to older methods such as the Sobel test which assumes that the potential indirect effects are normally distributed (35). Estimated coefficients and bootstrapped standard errors and 95%

confidence intervals are reported. The effect size of the mediated effect is reported as mediated R^2. This provides an estimate of the variance in the outcome explained by the mediated effect.

The conceptual model that underlies the intervention used in this analysis included several potential mediators of the treatment effect. In order to understand how these potential mediators contribute to the treatment effect, mediators were first tested as single mediator models (i.e., one mediator in the model). The variables that were found to be significant mediators of the treatment effect from the single models were then tested as part of a multiple mediation analysis where all significant mediators were included simultaneously. Separate models were tested for the behavioral and theoretical mediators.

Results

There were few differences between those randomized to the intervention group and the waitlist control group on the theoretical and behavioral constructs of interest at baseline (Table 1). The intervention group reported higher levels of positive outcome expectations for eating a healthier diet (4.26 ± 0.53 vs. 4.02 ± 0.67, $p = 0.02$) and for exercise (15.91 ± 5.11 vs. 13.46 ± 4.69, $p = 0.04$) than the control group. There were no differences in retention between treatment groups (p's = 0.98) with 101 participants returning for the three-month assessment (94.4%) and 97 returning for the six-month assessment (90.7%). There was a trend where those who took part in the three-month assessment were more likely to be married (81.2%) than those who did not (50.0%, $p = 0.07$). and those who returned for the six-month assessment were more likely to be employed full-time than those who did not (90.7% vs. 70.0%, $p = 0.05$). No other significant differences were observed (p's > 0.05).

The intervention produced a significant decrease in body weight at three and six months such that the average weight loss of those who returned for the six-month assessment in the intervention group was −5.57 kg (± 6.6) as compared to −0.65 kg (± 3.3) in the control group ($p < 0.001$). Similar changes were observed in analyses using multiple imputations to account for missing data (11).

Single mediation

Changes in the theoretical mediators between baseline and three months and the changes in the behaviors between baseline and six months are described in Table 1. The effects of the intervention on changes in the meditators are indicated as the A-path relationship in Table 2. All significant changes within the intervention group were in the expected direction, although changes were not observed for all mediators. For instance, the intervention group reported greater increases than the control group in feelings of autonomous motivation for healthy eating between the start of the program and the three-month assessment. Conversely, the intervention group reported greater decreases in perceptions of negative outcomes associated with eating a healthy diet than the control group.

The relationships between changes in the mediators between baseline and three months and change in weight between the baseline and six-month assessments, controlling for the effect of the intervention group, are shown in Table 2 (B-path). The associations between changes in weight and changes in autonomous motivation ($p = 0.02$), self-efficacy ($p = 0.001$), and self-regulation ($p < 0.001$) for diet were all statistically significant and in the expected direction. For example, increases in self-efficacy between baseline and three months were associated with greater weight losses between baseline and six months. Outcome expectancies for healthy eating (positive and negative) were not associated with weight change (p's = 0.19 and 0.20, respectively). Reductions in negative outcome expectancies for exercise were associated with reductions in weight ($p = 0.02$). There were trends for significant relationships between weight loss and changes in autonomous motivation for exercise ($p = 0.11$) and self-efficacy for exercise ($p = 0.07$), although these did not reach statistical significance. Changes in positive outcome expectancies for exercise were not associated with weight loss (p's ≥ 0.34). Changes in calorie intake ($p = 0.003$), calorie expenditure through physical activity ($p = 0.01$), and frequency of self-weighing ($p < 0.001$) between baseline and six months were also associated with changes in weight over the same period.

The indirect effect of the intervention on weight loss was mediated through diet-related constructs and the target behaviors of caloric intake, caloric expenditure through physical activity, and self-weighing. Autonomous motivation for eating a healthy diet (estimate = −0.72, 95% confidence interval: −1.41, −0.28), self-efficacy for eating a healthy diet (-1.06, 95% CI: −2.04, −0.42), and self-regulation of eating behaviors (−4.02, 95% CI: −6.35, −2.15) all mediated the relationship between the intervention and weight loss. For the exercise related constructs, only autonomous motivation for exercise mediated the relationship (−0.37, 95% CI: −0.89, −0.04). Changes in caloric intake (−0.97, 95% CI: −2.09, −0.34), caloric expenditure through physical activity (−0.91, 95% CI: −1.86, −0.23), and self-weighing frequency (−4.03, 95% CI: −5.99, −2.56) all significantly mediated the effect of the intervention as well.

Table 3 displays the tests of mediation of the treatment effect on changes in caloric intake and calorie expenditure through physical activity by the associated theoretical constructs. As shown in Table 3, the effects of the changes in the theoretical constructs on changes in the behaviors were largely non-significant. Only the change in autonomous motivation for exercise between baseline and three months significantly mediated the treatment effect on change in calorie expenditure through physical activity between baseline and six months (1.22, 95% CI: 0.07, 3.29). Because only one theoretical mediator was significant, the theoretical construct to behavior relationships were not further tested in multiple mediation.

Multiple mediator models

The significant mediators of the effect of the intervention on weight loss were tested in two models testing the effects of multiple mediators simultaneously. Models were developed that tested changes in the theoretical mediators and behavioral mediators of the treatment effects separately (Figures 3a and 3b). As shown in Table 4, autonomous motivation for diet (−0.82; 95% CI: −2.22, −0.11), self-efficacy for diet (−0.66; 95% CI: −1.63, −0.08), and self-regulation for diet (−3.06; 95% CI: −575, −0.71) mediated the treatment effect on weight loss after controlling for the effects of the remaining variables. However, autonomous motivation for exercise did not independently mediate the relationship between the intervention and weight loss (0.53; 95% CI: −0.10, 1.98).

The model testing the indirect effects of the behavioral mediators indicated that the intervention effects on weight change compared to the control group were achieved via changes in calorie intake (0.85; 95% CI: −1.90, −0.26) and self-weighing (−3.8; 95% CI: −6.24, −2.00) but not caloric expenditure through physical activity (−0.01 95% CI: −0.82; 0.89).

Discussion

This study tested the theoretical and behavioral mediators of a weight loss program developed for men. The results from the single and multiple mediation analyses suggest that the effect of the intervention on weight loss was significantly mediated by changes in many of the proposed constructs related to diet (autonomous motivation, self-efficacy, and self-regulation) and changes in self-weighing and eating behaviors. Further, changes in autonomous motivation for exercise and caloric expenditure through physical activity were significant mediators of the treatment effect only when tested in models of single mediation. Only changes in autonomous motivation for exercise between baseline and three months significantly mediated the relationship between the intervention and changes in calorie expenditure through exercise. No theoretical constructs mediated the relationship between the treatment effect and changes in diet.

Self-efficacy is often an intervention target of studies of behavioral weight control although it is not consistently associated with weight loss. In some studies, baseline self-efficacy has been associated with weight loss among men but not women (36-38). Similar to the results of the current study, changes in self-efficacy during treatment have also been associated with weight loss (17-19). The relationship between change in self-efficacy and weight loss is particularly important because some studies observe decreases in self-efficacy during an intervention (e.g., 19), suggesting that interventions need to insure adequate intervention strategies focused on preserving or increasing self-efficacy during intervention to maximize weight loss efforts.

Autonomous motivation was hypothesized to be an important construct to target when developing a weight loss program for men because independence is a key characteristic of masculinity (39). Additionally, in studies of women, change in autonomous motivation for diet has been found to mediate the relationship between an intervention and weight loss in the short-term (16) while autonomous motivation for exercise has been associated with long-term weight loss maintenance (15). The results of this analysis support results found in these previous studies. In this study, autonomous motivation for eating a healthy diet was a significant mediator of the treatment effect in the multiple mediation model as well as in the single model. On the other hand, autonomous motivation for exercise only mediated the intervention weight loss relationship in this single mediation model. This weaker relationship between autonomous motivation for exercise and initial weight loss supports the prior findings (15, 16), which suggest that autonomous motivation for exercise is less influential in the early stages of weight loss.

Self-regulation behaviors measured by the Eating Behavior Inventory and self-regulation through daily self-weighing both mediated the intervention's effects on weight loss in the single and multiple mediator models. The mediated effect of the intervention through daily self-weighing was stronger than the effects through diet or physical activity. Although this may be influenced by the measurement used (e.g., participants may be more accurate in recalls frequency of self-weighing versus eating or exercise behaviors), this finding supports the assertion that self-regulation is key for behavior change (13, 40). The finding that self-weighing frequency mediated the treatment effect supports the growing evidence that daily self-weighing is a simple form of self-regulation that can be important for weight loss and weight loss maintenance (20, 21, 41, 42).

The modest relationships between physical activity and weight loss found in this study add to the inconsistent relationships found between these variables in past studies of men. Some studies (7, 9, 36) have found that physical activity was associated with weight loss while other studies (8) have not found the same effect. Although weight loss can be achieved via physical activity alone, the general finding is that physical activity alone is not associated with significant weight losses (43) and that changes in diet are more closely associated with initial weight loss (e.g., 44). Alternatively, a relationship between physical activity and weight loss may have been present in this study but the questionnaire used to assess physical activity may not have been sensitive enough to allow detection of the relationship.

The intervention effects on the theoretical constructs related to physical activity in this study were minimal. This may be due in part to the intervention presentation of physical activity versus diet change. Although the theoretical constructs related to physical activity were targeted in similar ways to the diet related constructs, there was less weekly intervention content devoted to physical activity: most physical activity intervention content was delivered via the tailored feedback while the weekly lessons focused on diet. The focus on diet in the lessons was driven by prior studies that suggest men have greater difficulty making dietary changes than activity changes (7, 9, 45). Although participants completed more than 80% of intervention contacts, we were unable to assess how much time was spent on reading the tailored feedback. If participants skimmed the tailored feedback in order spend more time reading the lesson, it is possible that they received less information on physical activity.

This study additionally tested the relationships between the theoretical constructs described above and the behaviors they are hypothesized to change. Although changes in both diet and physical activity mediated the relationship between the intervention and weight loss, the theoretical constructs did not mediate the intervention to behavior relationship. It is not clear why these relationships were not observed. One potential explanation is that the self-report measurement of the theory constructs and the self-reported assessment of behaviors introduced sufficient measurement error that the current sample size was insufficient to detect the relationships. Self-reported measurement of diet and exercise behaviors is notoriously challenging and prone to errors (46). This is a logical explanation for the non-significant findings in the current study given that the relationships between one self-report measure (either construct or behavior) and the objectively measured weight change were generally in the expected direction, though not significant. Future studies will need a combination of larger samples sizes and more precise measurement of diet and physical activity in order to be better suited to assess these relationships.

Although this study tested the effects of change in the hypothesized mediators measured prior to the assessed change in the behaviors or weight control, the temporal aspects of these relationships are not fully independent. Because weight, diet, and physical activity were also changing between baseline and three months, when the changes in the hypothesized mediators were assessed, it is probable that changes in the mediators were due in part to changes in behaviors. For example, if a participant lost weight prior to the three-month assessment, he may have reported feeling more efficacious about changing eating and activity behaviors. Future studies will need to measure and test changes in theoretical constructs and behaviors more frequently in order to explore these temporal effects.

While this study contributes to the nascent literature on men's weight loss programs, there are limitations that need to be addressed in future studies. First, this study utilized a waitlist control condition. Although this was appropriate for testing the efficacy of the intervention, the minimal changes in the control group may have diluted this study's ability to detect relationships between the changes in the mediators and weight loss outcomes. Secondly, this study used data only from those participants who returned for the three- and six-month assessments. Although there was high retention to the study and few differences were observed between completers and dropouts, this reduced the available power for the analyses. The study also only followed participants over six months. Because there is evidence that predictors of weight loss are different than those of weight loss maintenance (15, 16), future studies will be needed to test these longer-term relationships with samples of men. Finally, this study was conducted using community volunteers: participants were primarily white, married, college educated men. Because this sample is not representative of all men with obesity, the results of this study may not be generalizable to other groups.

This study utilized data from a six-month randomized trial with excellent retention to test the effects of theoretical and behavioral constructs as mediators of the intervention effect on weight loss. By using established measures of the theoretical constructs, the results of this study can be compared descriptively to other studies and samples. By testing both single and multiple mediation models, this study was able to assess the mediators in isolation, which is often done in studies of behavioral trials, as well as testing the mediators together. This simultaneous analysis better fits the conceptual model underlying this intervention and most behavioral interventions, which are multicomponent and multidimensional. By focusing on theoretical mediators as opposed to focusing only on behaviors, this analysis contributes information that may be generalized beyond this intervention and can help future intervention developers to select intervention targets that are most consequential to men.

Acknowledgements

This research was supported by funding provided to M. M. Crane through the Cancer Control Education Program (5R25-CA057726) at Lineberger Comprehensive Cancer Center at The University North Carolina at Chapel Hill and through the Dissertation Completion Fellowship provided by The Graduate School at the University of North Carolina at Chapel Hill. The authors would like to thank Dr. Kurt Ribisl for his assistance in developing and critically evaluating this study while serving on M. M. Crane's dissertation committee. Clinicaltrials.gov identifier: NCT01843595.

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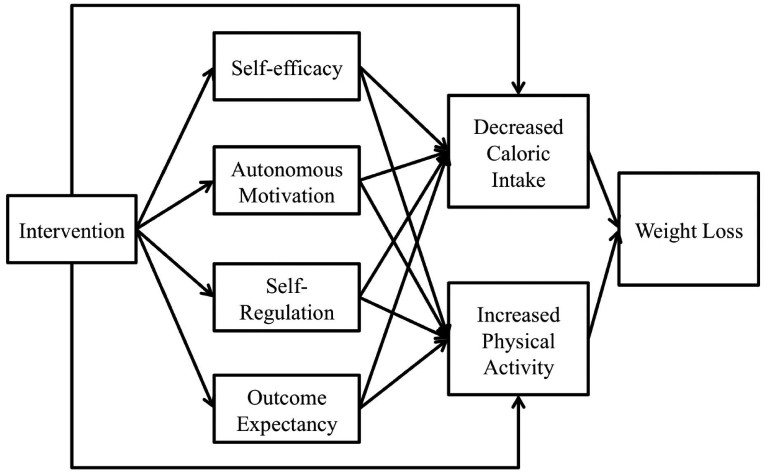

Figure 1.

Conceptual model of the REFIT intervention

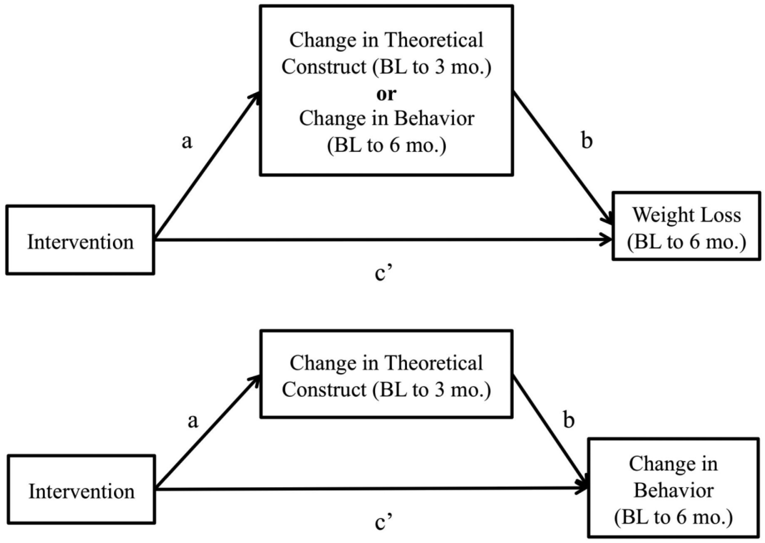

Figure 2.
Single mediation framework for weight loss outcomes (a) and behavior change outcomes (b).

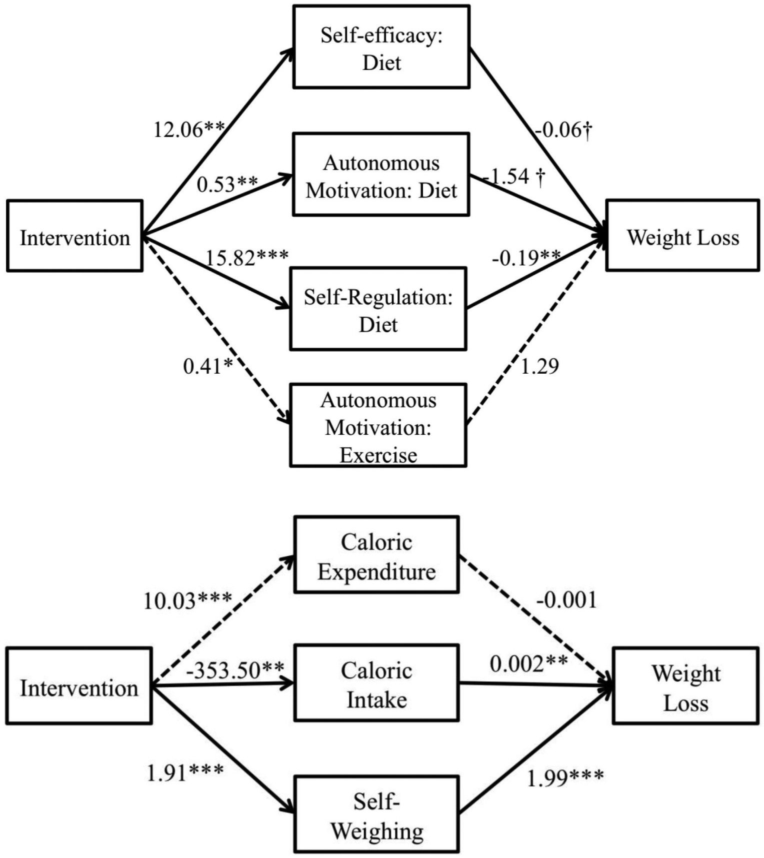

Figure 3.

Theoretical (a) and behavior (b) multiple mediation analyses Note: † $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 1

Observed Means by Treatment Group and Time

	Waitlist			REFIT			
	Baseline	**3 mos.**	**Within group**[a]	**Baseline**	**3 mos.**	**Within group**[a]	**Baseline Difference**[b]
Diet-related							
Autonomous motivation	5.78 ± 0.93	5.64 ± 1.17	0.60	5.87 ± 1.05	6.12 ± 0.98	0.02	0.63
Self-efficacy diet	122.01 ± 32.16	118.72 ± 35.01	0.12	126.59 ± 31.48	132.03 ± 30.00	0.009	0.46
Outcomes- Positive	4.00 ± 0.55	4.02 ± 0.67	0.67	4.26 ± 0.53	4.29 ± 0.50	0.45	0.02
Outcomes- Negative	2.94 ± 0.67	2.91 ± 0.75	0.94	2.69 ± 0.70	2.45 ± 0.53	0.008	0.06
Self-regulation	72.27 ± 8.78	74.32 ± 9.18	0.01	74.63 ± 8.38	91.72 ± 10.00	<0.001	0.16
Exercise-related							
Autonomous motivation	5.92 ± 0.92	5.74 ± 1.23	0.25	6.17 ± 1.07	6.21 ± 0.98	0.47	0.21
Self-efficacy	3.87 ± 0.69	3.78 ± 0.83	0.12	3.88 ± 0.69	3.81 ± 0.75	0.55	0.95
Outcomes- Positive Health	18.80 ± 4.63	17.98 ± 5.08	0.21	18.89 ± 4.17	18.78 ± 4.73	0.37	0.92
Outcomes- Positive Affect	14.01 ± 4.48	13.46 ± 4.69	0.24	15.91 ± 5.11	15.75 ± 4.85	0.64	0.04
Outcomes- Negative	10.03 ± 4.69	9.22 ± 4.67	0.22	9.43 ± 4.36	8.81 ± 3.72	0.41	0.50
	Baseline	6 mos.		Baseline	6 mos.		
Behaviors							
Intake (kcals)	2460± 619	2286 ± 693	0.17	2333 ± 665	1890 ± 468	<0.001	0.30
Exercise (kcals)	1056 ± 1096	928 ± 805	0.91	1033 ± 1176	1650 ± 1303	0.001	0.77
Self-weighing frequency	3.44 ± 1.68	3.49 ± 1.52	0.21	3.68 ± 1.59	5.60 ± 0.84	<0.001	0.46
Weight (kg)	99.95 ± 14.78	99.43 ± 15.00	0.17	99.61 ± 14.30	94.46 ± 13.64	<0.001	0.91

Note. All values are mean ± standard deviation.

[a]Within group differences results of paired sample t-tests.

[b]Differences at baseline tested with independent t-tests.

Table 2

Single Mediation Analyses with Weight Outcome

	A-path (s.e.)	B-path (s.e.)	Indirect Effect (95% CI)	Direct Effect (s.e.)	Effect Size (med R^2)
Diet-related Constructs					
Autonomous motivation	0.51 (0.18)**	−1.41(0.59)*	**−0.72 (−1.41, −0.28)**	−4.21 (1.06)***	0.06
Self-efficacy	12.17 (4.01)**	−0.09 (0.03)**	**−1.06 (−2.04, −0.42)**	−4.30 (1.06)***	0.09
Positive outcomes	0.10 (0.10)	−1.51 (1.16)	−0.15 (−0.83, 0.07)	−4.98 (1.06)***	0.01
Negative outcomes	−0.34 (0.10)**	1.35 (1.06)	−0.46 (−1.20, 0.01)	−4.67 (1.12)***	0.05
Self-regulation	14.84 (1.56)***	−0.27 (0.06)***	**−4.02 (−6.35, −2.15)**	−0.77 (1.35)	0.18
Exercise-related Constructs					
Autonomous motivation	0.36 (0.17)*	−1.03 (0.63)	**−0.37 (−0.89, −0.04)**	−4.56 (1.06)***	0.04
Self-efficacy	0.07 (0.12)	−1.61 (0.90)	−0.11 (−0.66, 0.24)	−5.05 (1.04)***	0.01
Positive health outcomes	1.15 (0.69)	0.15 (0.16)	0.17 (−0.08, 0.83)	−5.47 (1.07)***	−0.001
Positive affective outcomes	1.22 (0.63)	−0.04 (0.18)	−0.05 (−0.85, 0.34)	−5.25 (1.08)***	0.01
Negative outcomes	−0.13 (0.68)	0.37 (0.16)*	−0.05 (−0.60, 0.54)	−5.25 (1.03)***	0.004
Behaviors					
Intake (kcals)	−353.50 (111.76)**	0.003 (0.001)*	**−0.97 (−2.09, −0.34)**	−4.13 (1.04)***	0.08
Exercise (kcals)[a]	9.49 (2.69)***	−0.10 (0.04)*	**−0.91 (−1.86, −0.23)**	−4.06 (1.07)***	0.08
Self-weighing frequency	1.92 (0.22)***	−2.10 (0.44)***	**−4.03 (−5.99, −2.56)**	−1.07 (1.26)	0.20

Note.

Bold typeface indicates 95% bias corrected bootstrap interval exclusive of zero.

* $p < 0.05$,

** $p < 0.01$,

*** $p < 0.001$.

[a] Analysis performed on square root transformed values.

Table 3

Single Mediation Analyses with Diet and Physical Activity Outcomes

	A-path (s.e.)	B-path (s.e.)	Indirect Effect (95% CI)	Direct Effect (s.e.)	Effect Size (med R^2)
Diet-related: Change in Calorie Intake as Outcome					
Autonomous motivation	0.54 (0.18)**	−34.73 (64.24)	−18.73 (−90.19, 40.36)	−360.66 (115.47)**	0.02
Self-efficacy	12.17 (4.01)**	−3.95 (2.90)	−48.13 (−161.54, 27.82)	−363.56 (115.82**	0.04
Positive outcomes	0.11 (0.10)	−17.15 (124.19)	−1.93 (−42.27, 21.30)	−378.29 (113.93)**	0.003
Negative outcomes	−0.35 (0.10)**	−8.46 (113.60)	2.94 (−72.51, 90.12)	−383.16 (119.79)**	0.01
Self-regulation	15.10 (1.55)***	1.29 (7.46)	19.49 (−155.56, 209.42)	−387.64 (158.10)*	0.05
Exercise-related: Change in Caloric Expenditure[a] as Outcome					
Autonomous motivation	0.36 (0.17)*	3.39 (1.63)*	**1.22 (0.07, 3.29)**	8.36 (2.74)***	0.03
Self-efficacy	0.07 (0.12)	6.23 (2.32)**	0.44 (−0.96, 2.41)	9.56 (2.68)***	0.01
Positive health outcomes	1.15 (0.69)	0.50 (0.41)	0.58 (−0.56, 2.69)	9.99 (2.77)***	0.02
Positive affective outcomes	1.22 (0.63)	0.66 (0.45)	0.81 (−0.15, 3.39)	9.76 (2.78)***	0.03
Negative outcomes	−0.13 (0.68)	0.25 (0.42)	−0.03 (−1.02, 0.45)	10.60 (2.74)***	<0.01

Note.

Bold typeface indicates 95% bias corrected bootstrap interval exclusive of zero.

* $p < 0.05$,

** $p < 0.01$,

*** $p < 0.001$.

[a] Analysis performed on square root transformed values.

Table 4

Multiple Mediator Analyses

	Coefficient (s.e.)	95% Confidence Interval
Model 1.		
Total Effect (c-path)	**−5.22 (1.06)**	**−7.34; −3.11**
Direct Effect (c'-path)	−1.21 (1.45)	−4.10; 1.68
Indirect Effects		
Autonomous motivation: Diet	**−0.82 (0.50)**	**−2.22; −0.11**
Self-efficacy: Diet	**−0.66 (0.38)**	**−1.63; −0.08**
Self-regulation: Diet	**−3.06 (1.27)**	**−5.75; −0.71**
Autonomous motivation: Exercise	0.53 (0.52)	−0.10; 1.98
Model 2.		
Total Effect (c-path)	**−5.10 (1.03)**	**−7.15; −3.05**
Direct Effect (c'-path)	−0.44 (1.24)	−2.91; 2.02
Indirect Effects		
Intake (kcals)	**−0.85 (0.40)**	**−1.90; −0.26**
Exercise (kcals)[a]	−0.01 (0.43)	−0.82; 0.89
Self-weighing frequency	**−3.81 (1.07)**	**−6.24; −2.00**

Bold typeface indicates 95% bias corrected bootstrap interval exclusive of zero.