Adherence to Self-Monitoring Predicts Weight Loss and Weight Regain in Rural Breast Cancer Survivors

By

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Abstract

Background: Pre-packaged food is a common and successful dietary approach used in commercial, medically supervised, and some academic weight loss programs. Prepackaged food enhances weight loss results and minimizes weight regain, however the role of self-monitoring has not been investigated. Predictors of self-monitoring adherence have also not been addressed.

Objective: To examine the role of self-monitoring consistency in weight loss and weight loss maintenance in which prepackaged entrees, meal replacement shakes, servings of fruits and vegetables, unplanned snacks and meals out were tracked ≥5 days/week. Depressive symptoms as a predictor of self-monitoring adherence were explored.

Methods: 210 Breast cancer survivors (BMI=27 to 45kg/m^2) living in the rural Midwest enrolled in an intervention with two phases: non-randomized 6-month weight loss followed by 12-month weight maintenance where participants were randomized to either continued bi-weekly conference calls or bi-weekly newsletters. Final analyzed sample included 191 participants.

Results: Higher weekly self-monitoring consistency was associated with higher weight loss at 6 months, $F(2, 189) = 29.87$, $p<0.001$, $R^2=0.13$. Higher levels of self-monitoring predicted lower weight regain at 18 month, $\beta_4 = 0.10$, $t(254.9) = 3.012$ $p = 0.0029$. Depression severity measured at baseline significantly predicted average self-monitoring consistency across the first 6 months, $F(1,189) = 5.91$, $p<0.02$; $R^2=0.025$. Depressive symptom severity at 6 months predicted average self-monitoring consistency across months 6 to 18, $F(1,166) = 9.95$, $p=0.002$, $R^2=0.051$.

Conclusion: Weight management relies on self-regulation strategies promoted by self-monitoring and food environment. These strategies may help individuals continue positive behavior changes long term. Mood may need to be addressed as a barrier to self-monitoring.

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Adherence to Self-Monitoring Predicts Weight Loss and Weight Regain in Rural Breast Cancer Survivors

Background

Pre-packaged food is a common and successful dietary approach used in commercial, medically supervised, and academic behavioral weight loss programs. In programs such as Jenny Craig®, Nutrisystem®., Weight Watchers®, Medifast®, and Health Management Resources®, as well as some academic behavioral lifestyle intervention studies, individuals may purchase prepackaged meals that facilitate meal plan adherence and, thus, daily caloric goal adherence (Cook, McCormick, Knowles, & Kaden, 2017; Donnelly et al., 2007; Finley et al., 2007; Foster et al., 2009; Heshka et al., 2000; Martin, Talamini, Johnson, Hymel, & Khavjou, 2010; Rock et al., 2010). Prepackaged food diets control food portion sizes and reduce caloric intake; subsequently, participants lose more weight than those who do not follow a prepackaged food diet (Rock et al., 2016). Jenny Craig® and Weight Watchers® have program options to incorporate group or individual social support and problem solving as behavioral weight management strategies. These programs also provide tracking systems through which prepackaged food and points for self-procured foods can be tracked by an individual; however, self-monitoring's role in weight management has otherwise yet to be established in published, peer-reviewed research (Anderson, Reynolds, Bush, Rinsky, & Washnock, 2011; Tsai & Wadden, 2005).

Self-regulation theory proposes self-monitoring as a behavioral strategy in which an individual monitors observed behavior and then adjusts this behavior to match a targeted goal or social situation (Bandura, 1998). Within this behavioral feedback loop, an individual observes or records a targeted behavior, evaluates the extent to which the targeted behavior occurs, and then

participates in a reinforcement process wherein the individual adjusts behaviors to match targeted behaviors. Through this process of assessment and revision, an individual moves toward targeted goals. Self-monitoring can be adapted to a variety of behaviors and social contexts and has been referred to as the "cornerstone" of behavioral strategies for weight loss and weight management (Baker & Kirschenbaum, 1993). Self-monitoring requires an individual to track their diet using a structured format, such as paper-and-pencil or electronic journaling. In doing so, the individual participates in a self-monitoring behavioral feedback loop, thereby increasing self-awareness and allowing the individual to assess and monitor dietary goals.

Adherence to self-monitoring of dietary components is positively correlated with weight loss results (Baker & Kirschenbaum, 1993; Boutelle & Kirschenbaum, 1998; Burke, Wang, & Sevick, 2011; Laitner, Minski, & Perri, 2016; Painter et al., 2017; Peterson et al., 2014). However, measurement of adherence to self-monitoring of dietary components has yet to be standardized. Presently, three competing definitions of adherence have emerged: comprehensiveness, frequency, and consistency. Comprehensiveness, or how 'complete' an individual tracks, is calculated via a study-specific point system where food name, calories, amount consumed, and time of day are summed and divided by the total possible points a participant could have acquired per each study-specific time point. Frequency involves the number of daily self-monitoring records that were returned by participants. Consistency refers to the number of weeks self-monitoring occurred equal to a specified number of days, ranging from 3 to 5 days per week. Increased comprehensiveness was not found to be associated with increased weight loss (Peterson et al., 2014). Increased frequency (Burke et al., 2008; Laitner et al., 2016) and consistency (Baker & Kirschenbaum, 1993; Boutelle & Kirschenbaum, 1998) have both been found to be associated with increased weight loss (Painter et al., 2017; Peterson et al.,

2014). In a recent study, consistency was found to be more important than frequency for weight regain. Further, high frequency was only a significant predictor of weight loss if an individual was also highly consistent (Peterson et al., 2014). Consistent self-monitoring, therefore, is crucial to weight loss and weight loss maintenance.

The relationship between self-monitoring adherence and weight loss is well studied during the weight loss and weight maintenance phases of behavioral weight loss protocols, however weight regain during the maintenance phase remains common. Individuals who participate in behavioral weight loss protocols commonly achieve a clinically meaningful level of weight loss >5% from their baseline weight (Wadden, Butryn, Hong, & Tsai, 2014); however, this weight loss is not always permanent. Perri & Corsica (2002) summarized that, five years after the initial weight loss intervention, approximately half of individuals returned to their baseline weight. In a recent study, during months 7-18 (weight maintenance phase), self-monitoring consistency decreased from 70.7% of weeks at seven months to 29.8% of weeks at 18 months (Peterson et al., 2014). As consistency in tracking dietary components decreases, the evaluative process of tracking behavioral goals decreases, and an individual becomes vulnerable to weight regain.

Studies on self-monitoring adherence have utilized daily total calorie tracking during which individuals are required to estimate portion sizes and look up calories rather than tracking specific food types (e.g., meal replacement shakes, prepackaged entrees, servings of fruit/vegetables, among other study-specific items). Total caloric tracking can be problematic for many individuals as it requires individuals to accurately record, estimate portion sizes, and look up calories of all the meals that they are making at home or eating outside of their home environment. This process can be prone to error and ultimately time consuming for the

individual which may impact the self-monitoring process. One small pilot study investigated tracking differences between total calorie tracking (portion sizes, calories, and fat content) and tracking only specific food items (type of meals/snacks and estimating fat content) (Helsel, Jakicic, & Otto, 2007). Participants randomized to track only specific items were initially instructed to record the type, quantity, total calories, and to estimate the fat grams associated with each food or snack during the first eight weeks of the study. After the initial 8 weeks of the intervention, participants were instructed to only track specific items; only the type of meals/snacks was recorded and fat content was estimated. Participants randomized to this type of tracking returned more records than individuals who tracked total calories, however, no significant different with regard to weight loss was found (Helsel et al., 2007). These findings suggest that tracking specific items, rather than tracking portion size and calories may work well to effectively improve self-monitoring adherence. Tracking specific items would apply to structured diets such as prepackaged food commonly utilized in commercial weight loss programs.

To date, few studies have focused on predictors of self-monitoring adherence. Limited evidence suggests that females may be more likely than males and individuals who identify as White may be more likely than non-white individuals to adhere to self-monitoring (Hollis et al., 2008). Psychosocial factors and rural-urban living may also predict self-monitoring adherence; however, these factors have not yet been examined. Evidence suggests that individuals with clinical (Busch et al., 2013; Pagoto et al., 2007; Pagoto et al., 2013) and subclinical (Brumpton, Langhammer, Romundstad, Chen, & Mai, 2013) depressive symptoms are less successful at weight loss; therefore, depressive symptoms may be a moderating factor for adherence to self-monitoring not yet investigated.

Current Study

The impact of self-monitoring adherence on weight loss and weight loss maintenance in the context of total dietary tracking has been well documented (Boutelle & Kirschenbaum, 1998; Burke et al., 2011; Laitner et al., 2016; Painter et al., 2017; Peterson et al., 2014); however, self-monitoring's role has yet to be addressed when using a structured prepackaged food diet plan, typical of many commercial, medically supervised, and some academic weight loss programs. The use of prepackaged food enhances weight loss results and minimizes weight regain (Hannum et al., 2004); however, to our knowledge, no study has addressed the role of self-monitoring in these programs. Self-monitoring may still be important to weight loss and weight loss maintenance success in the setting of a structured prepackaged food diet plan, as the self-regulatory skills practiced through self-monitoring may help individuals continue positive behavior changes that facilitate weight and dietary goals over the long term. Accordingly, the goal of this study was to explore the role of self-monitoring consistency, in which specific dietary items (e.g., prepackaged meals, meal replacement shakes, servings of fruits and vegetables, and unplanned snacks) are tracked during weight loss and weight loss maintenance phases. The present study also explores depressive symptoms as a predictor of self-monitoring adherence.

Aims

Study Aim 1: How does self-monitoring consistency across the weight loss intervention period influence weight loss at the end of the weight loss intervention period?

Hypothesis 1: Higher self-monitoring consistency across the weight loss period will be associated with greater weight loss at the end of the weight loss intervention period.

Study Aim 2: How does self-monitoring consistency during the weight maintenance period predict weight regain?

Hypothesis 2: Higher self-monitoring consistency will predict lower weight regain.

Study Aim 3: How do initial depressive symptoms affect self-monitoring consistency across the weight loss period? How do depressive symptoms at the end of the weight loss period affect self-monitoring consistency across the weight maintenance period?

Hypothesis 3: Higher baseline depressive symptoms will predict lower self-monitoring consistency at the end of the weight loss period. Higher depressive symptoms at the end of the weight loss period will predict lower self-monitoring consistency at the end of the weight maintenance period.

Methods

Participants

Data for the present study were collected as part of the parent trial which was reviewed and approved by the Institutional Review Board of the University of Kansas Medical Center. The parent trial included 210 breast cancer survivors ≤75 years of age (*M*=58.0 years, *SD*=8.2) with body mass index 27 to 45kg/m^2 (*M*=34.0kg/m^2, *SD*=4.4) (Befort et al., 2012). Participants were post-menopausal women living in the rural Midwest and had completed treatment for Stage I-IIIc breast cancer within the past 10 years. Rurality was defined by the Rural Urban Commuting Area (RUCA) codes established by the U.S. Department of Agriculture, Economic Research Service. Participants were excluded if they endorsed unstable cardiopulmonary conditions,

severe mental illness that would impede them from participating in a group counseling format, or were unable to walk briskly unassisted for at least 10 minutes. Participants endorsing prior weight loss surgery or concurrent participation in other weight loss programs or endorsed binge eating were excluded. Participants were also excluded if they received chemotherapy or local breast cancer treatment within three months from study start date and were not weight stable (within 10 pound fluctuations over three months). Weight instability was an exclusion criterion as it would be difficult to attribute weight fluctuation was associated with the intervention. All participants obtained physician clearance prior to inclusion.

The parent trial took place over five years and consisted of two intervention phases: weight loss (baseline to 6 months) and weight maintenance (months 6 to 18). The weight loss intervention targeted a 10% weight loss goal during the first six months and included weekly 60-minute group conference calls led by an interventionist. The intervention targeted decreased caloric intake, increased physical activity, and behavioral strategies including stimulus control and problem solving to promote weight loss. Physical activity goals were gradually increased to 225 minutes per week of moderate physical activity. During the first six months, participants were instructed to consume two meal replacement shakes, two prepackaged entrees, five one-cup servings of fruits/vegetables, and minimal snacks and meals out. Participants obtained and purchased their own food except for whey protein shakes which were provided to participants by the study for the first six months after which participants were responsible to obtain on their own. During the weight loss maintenance phase (months 6 to 18), participants were encouraged to continue to purchase and consume prepackaged shakes and entrees for breakfast and lunch and to prepare a homemade meal for dinner. During the weight loss maintenance phase participants were instructed to incorporate more home-prepared meals, maintain high fruit/vegetable

consumption, and limit meals out. Dietary components were tracked daily via paper logs sent to interventionists via fax, email, or voicemail.

A total of 210 participants were enrolled into the study at baseline. 191 Participants competed the initial weight loss phase and were randomized into the weight maintenance phase. Participants were randomized into two groups: one group received bi-weekly 60-minute group counseling sessions via conference calls led by an interventionist, while the control group was not in contact with the interventionist and received bi-weekly educational newsletters promoting weight maintenance. Baseline participant characteristics are summarized in Table 1.

Measures

Weight. Participant's weight was measured in light clothing without shoes and was measured to the nearest 0.1 pound using a digital scale (+0.1, Befour, Inc). Weight was measured at baseline, 6 months, 12 months, and 18 months.

Dietary Self-Monitoring Records. Participants completed weekly self-monitoring records and were instructed to record the number of daily food and beverage intake, including meal replacement shakes, prepackaged entrees, one-cup servings of fruits/vegetables, and snacks and meals out. These records were transmitted to the study leaders via email, fax, or voicemail and were entered into a database. During the maintenance phase of the study, participants were instructed to continue to record daily food and beverage intake and to transmit these records to study leaders. Both intervention groups (phone and mail) received the same instructions. Self-monitoring consistency was defined as the number of weeks that participants recorded food and beverage intake for five or more days. This tracking threshold has been utilized by other self-monitoring studies (Painter et al., 2017; Webber, Tate, Ward, & Bowling, 2010).

Patient Health Questionnaire (PHQ-9). A validated 9-items questionnaire, scored on a 0-3 Likert-type scale used to assess depression severity. Total scores range from 0-27. In a comprehensive review the PHQ-9 was reported to have strong reliability (average coefficient alpha= 0.89) and a strong construct and criterion validity (K. Kroenke, Spitzer, & Williams, 2001). Scores greater than or equal to 15 were considered clinically significant for depression (K. M. D. Kroenke & Spitzer, 2002).

Data Analysis

R version 3.4.3 (R Foundation for Statistical Computer, Austria) and the multilevel modeling packages (lme4 and lmerTest) were used to conduct the statistical analyses (Bates, Mächler, Bolker, & Walker, 2015; Kuznetsova, Brockhoff, & Christensen, 2017). An alpha level of .05 was selected to test model significance. For this study three separate linear regressions (aims 1 and 3) and a multilevel growth model (MGM; aim 2) utilizing random slope and random intercept were conducted. The MGM was conducted to assess change in the outcome variable of weight development across the weight maintenance phase (6 months, 12 months, 18 months). To account for the nonlinear pattern of weight change, a random slope and random intercept were used. To test significance of the fixed effects Satterthwaite approximations to degrees of freedom were conducted. The first stage of the aim 2 analysis was to determine if a multi-level model was necessary. Commonly an Intraclass Correlation Coefficient (ICC) is calculated to determine this, with values above 0.10 calling for MGM. The obtained ICC is 0.814 which is very large, suggesting that individuals are following increasing or decreasing trajectories independently. A high ICC suggests a large portion of variance is nested within participants. This violates the compound symmetry assumption of ANOVA; therefore, the analysis addressing the second hypothesis should only be conducted in a Multilevel framework. An unstructured covariance matrix was used for fixed effects and a

symmetric covariance matrix was used for random effects. Furthermore, the random effect of the slope was significant after conducting a nested model likelihood ratio test, X^2 (8, N =2) = 64.32, p <.01.

Results

Characteristics of the sample

Of the participants who began the study (n=210), 19 participants did not have body weight recorded at six months and were removed from the analyses (n=191). The analyzed sample of 191 participants had a BMI range of 27 to 45kg/m^2 (*M*=33.93 kg/m^2, *SD*=4.41). Participant descriptive characteristics are summarized in Table 1. Weekly average self-monitoring consistency was highest during the first six months of the weight loss phase (*M* = 90.60% completed, *SD*= 16.35%) and decreased during the weight maintenance phase. During the weight maintenance phase, weekly average self-monitoring consistency decreased from the first quarter (*M* = 63.48%, SD= 38.29%) to the last quarter (*M* = 37.52%, *SD* = 43.63%; Figure 1; Table 2). Average PHQ-9 depressive symptom scores remained subclinical (≤15) across study time points (baseline; *M*=4.00, *SD*=3.67; end of weight loss period; *M*=2.59, *SD*=3.34; end of maintenance period *M* = 3.34, *SD* = 2.94) with a significant decrease from baseline to six months (*p*<.001) but not from baseline to 18 months (*p*=0.055). In total four participants scored above this depressive symptom threshold at any time point. Two participants scored above threshold at baseline and two scored above threshold at six months. One of the participants who scored above threshold at 6 months also scored above threshold at 18 months.

Study Aim 1

A linear regression was performed to examine the relationship between weekly self-monitoring consistency and weight change during the initial weight loss phase (Table 3). Higher weekly self-monitoring consistency was associated with greater weight loss at the end of the weight loss period, $F(2, 189) = 29.87$, $p<0.001$, $R^2=0.13$. Specifically, for every one week increase of consistent self-monitoring (tracking specific food items for five or more days), participants experienced an average weight loss of 0.55 kg at the end of the weight loss period ($\beta_1 = 0.55$, $t(189)=0.10$, $p<0.001$).

Study Aim 2

In the MGM model, first the relationship between time and the outcome variable of weight (kg) across the study time points (6 months, 12 months, 18 months) was entered into the model at the individual level. Self-monitoring, treatment arm (phone or mail), and the interactions between weight slope with treatment arm, self-monitoring with treatment arm, weight slope with self-monitoring, and weight slope, self-monitoring, and treatment arm were entered into the model.

Higher levels of self-monitoring predicted lower weight regain, $B_4 = 0.10$, $t(254.9) = 3.012$, $p = 0.0029$. Participants in the phone arm had higher self-monitoring, $B_5 = 0.53$, $t(268.1) = 3.010$, $p = 0.0029$ and lower weight regain, $B_3 = 1.58$, $t(338.2) = 2.40$, $p = 0.017$. However, weight slope interaction with self-monitoring did not vary by treatment arm (Table 4).

Study Aim 3

To examine the effect depressive symptoms have on self-monitoring consistency, linear regressions were performed. The first linear regression conducted utilized depressive symptom severity at baseline to predict average self-monitoring consistency during the weight loss phase

(baseline to 6 months). Higher depressive symptoms at baseline were significantly related to lower average self-monitoring consistency across the weight loss phase (the first six months), $F(1,189) = 5.91$, $p<0.02$; $R^2=0.025$. A second linear regression utilizing depressive symptom severity measured at six months was used to predict average self-monitoring consistency during the weight maintenance phase (months 6 to 18). Higher depressive symptoms at six months, predicted lower average self-monitoring consistency across the weight maintenance phase (months 6 to 18), $F(1,166) = 9.95$, $p=0.002$, $R^2=0.051$ (Table 5).

Separate exploratory analyses were conducted to investigate the association between depressive symptoms and weight change. A linear regression utilized depressive symptom severity at baseline to predict weight loss at the end of the weight loss phase (month 6). Depressive symptom severity at baseline was not found to significantly predict weight loss at the end of the weight loss phase (month 6), $F(1,189) = 3.728$, $p=0.055$, $R^2=0.014$. A second linear regression utilized depressive symptom severity at 6 months to predict weight regain at the end of the weight maintenance phase (month 18). Depression symptom severity at 6 months was not found to significantly predict weight regain at the end of the weight maintenance phase (month 18), $F(1,166) = 1.936$, $p=0.166$, $R^2=0.006$.

Discussion

The present study supports that, in a population of rural breast cancer survivors, consistent self-monitoring of food items from a diet consisting of prepackaged entrees, shakes, greater than five one-cup servings of fruits and vegetables and limiting snacks and meals out is associated with weight loss; furthermore, self-monitoring consistency is also associated with less weight regain after the use of prepackaged entrees and meal replacement shakes decreases. This

novel finding demonstrates that even when following a diet that utilizes prepackaged food, the process of self-monitoring or practicing self-regulation skills is still required of individuals in order to make lasting changes.

A key factor of incorporating a structured prepackaged food diet plan is whether or not the food is provided with or without cost to participants. In this study participants purchased their own entrees and other food, but meal replacement shakes were provided without cost to participants during the weight loss phase (first 6 months) and then were available for participants to purchase during the weight maintenance phase (months 6 to 18). Making food available to participants without cost or with the presence of incentives tends to improve weight loss outcomes and is a way to reduce barriers during the weight loss phase (Jeffery et al., 1993; Rock et al., 2010). While acquiring food without cost or in the presence of incentives may lead to higher weight loss results, the role of self-monitoring when food is provided without charge or with incentives needs to be a future area of investigation.

In the present study, weekly average self-monitoring consistency was highest with 90.60% of weeks of ≥5 days recorded during the first 6 months of the weight loss phase and decreased to 37.52% of weeks of ≥5 days recorded at the end of the weight maintenance phase. These results parallel two recent behavioral weight loss studies; one by Laitner et al. (2016) who reported, self-monitoring adherence was the highest during the first 6 months of the weight loss phase, with approximately 70.89% to 82.24% of records completed and decreased to approximately 26.55% to 55.49% of records completed at the end of the maintenance phase (month 18) for both low and high weight loss groups, respectively (Laitner et al., 2016). In another behavioral weight loss study focusing on a 12-month weight maintenance phase, self-monitoring adherence decreased across the weight maintenance phase. Self-monitoring

adherence was highest at the beginning of a weight maintenance phase (month 7) with 70.7% of weekly records completed and decreased to 29.8% of weekly records completed at month 18 (Peterson et al., 2014). These results support the previously reported trend that self-monitoring adherence is highest during the weight loss intervention phase and decreases across an 18-month study period. In our study, self-monitoring consistency was higher, but decreased to similar self-monitoring consistency levels by the end of 18 months. Prepackaged food may increase self-monitoring adherence by providing an individual with less items to track overall, accounting for the high adherence rate during the first 6 months of the weight loss phase. Once individuals transition into the weight loss maintenance phase, prepackaged food remains a dietary option, however most individuals transition to self-prepared meals for at least part of their daily meals. Switching back to meals prepared in the home may account for similar consistency results at the end of 18 months with other studies that focus on total dietary caloric tracking.

As previously published in the main outcomes paper (Befort, Nazir, & Perri, 2012), participants in the phone arm regained less weight than those randomized to the mail group. We found that participants in the phone arm also showed higher self-monitoring consistency compared to the mail arm throughout the year-long maintenance period. This relationship was expected as self-monitoring is an important behavioral strategy that promotes self-regulation regardless of treatment arm. Participants randomized to the phone group may have had more opportunity to practice tracking behavioral goals, evaluating and adjusting these goals, and receiving positive reinforcement for behavioral changes in a group setting. Thus, findings support the evidence indicating that accountability and feedback to self-monitoring is one of the 'active ingredients' of weight loss maintenance interventions.

This is the first study that we are aware of to show that higher depressive symptom scores

in a non-clinically depressed population are associated with lower average self-monitoring consistency. Specifically, the present study suggests that for every one-point increase in depressive symptomatology there was a corresponding decrease in dietary tracking by 0.5 days during the weight loss phase and by 2.5 days during weight maintenance phase. While the association between depressive symptoms and self-monitoring is an area that requires further investigation, these findings are consistent with evidence suggesting that individuals with clinical (Busch et al., 2013; Pagoto et al., 2007; Pagoto et al., 2013) and subclinical (Brumpton et al., 2013) depressive symptoms are less successful at weight loss. Depressive symptoms are broadly characterized by cognitive and physical symptoms including but not limited to feelings of hopelessness, worthlessness, guilt, exhaustion, and fatigue (Kessler, Petukhova, Sampson, Zaslavsky, & Wittchen, 2012). Tracking difficulty may be interpreted by the individual with depressive symptoms as a personal failure due to symptoms of worthlessness and guilt. This cognitive appraisal can then enhance vulnerability of future weight gain by decreasing an individual's ability to positively problem solve and otherwise facilitate self-regulatory behaviors such as self-monitoring. In total only four participants scored above threshold at any time point, supporting that our study sample predominately experienced subclinical depressive symptoms. While our study does not focus on a clinically depressed population, depressive symptoms in a subclinical population may be a measure of an individual's ability for self-regulation.

In our exploratory analyses we did not find a significant relationship between subclinical depressive symptoms and weight loss and weight regain. These exploratory analyses contradict the finding that subclinical depressive symptoms may be associated with weight loss outcomes (Brumpton et al., 2013); however, differences between the Brumpton et al. (2013) study and the current study may account for this outcome. Brumpton et al. (2013) used a different depressive

symptom inventory (Hospital Anxiety and Depression Scale; HADS) to measure symptoms and recruited participants from a community sample of men and women not currently enrolled in a behavioral weight loss study. Comparing subclinical depressive symptoms between study samples may be difficult. Individuals are often excluded from behavioral weight loss studies for clinical depressive symptoms or a clinical diagnosis of major depressive disorder. The role of subclinical and clinical depressive symptomatology in weight loss and weight maintenance remains an area of future research.

Limitations

There several limitations of the present study. First, not much is known about individual-level factors that predict self-monitoring consistency over time. In this study only one psychologically related variable was available, depressive symptom severity as measured by the PHQ-9, Secondly, in the parent study, the study population was restricted to post-menopausal women with a history of breast cancer living in the rural Midwest. While this study's findings are consistent with previous studies, it is unclear how these results translate into the general population or other minority groups.

An additional limitation to the study is that it was not designed to examine rural cultural eating attitude surrounding prepackaged food. Prepackaged food was well-accepted by participants, as they were able to purchase these food items either in their hometown grocery stores or during routine trips to larger grocery chains with lower costs. This structured diet successfully led to high levels of weight loss in the current study, the extent to which it would generalize to a less motivated and diverse rural population is not known. Limited research has been dedicated to the various dietary profiles in rural settings, but evidence points to a traditional 'meat and potato' high fat diet (Flora C, 2004). Physical labor and a subsequent high caloric

expenditure once offset traditional high fat diets, however, farming mechanization has reduced physical labor requirements (Pearson & Lewis, 1998). Additionally, the rural food environment continues to have limited access to healthy food choices as fast food and convenience stores (Dairy Queen, Pizza Hut, gas stations) continue to be the most common restaurants in rural communities (Creel, Sharkey, McIntosh, Anding, & Huber, 2008). Prepackaged food may be a convenient and economical alternative to high calorie and high fat food that can reduce the complexity of meal planning. Acceptability of using prepackaged or proportioned food for weight loss in rural settings deserves additional attention.

Conclusion

Successful weight loss and weight loss maintenance relies on individual levels of self-regulation strategies promoted through self-monitoring and food environment. The use of prepackaged food controls the food environment during a weight loss intervention and tracking prepackaged food items allows individuals to practice self-regulatory behavior in a controlled setting. As individuals transition to weight loss maintenance phases, the use of prepackage food tends to decrease and the food environment becomes less controlled. The self-regulatory skills practiced through self-monitoring may help individuals continue these positive behavior changes long term. Further, identifying that elevated depressive symptoms in a non-clinically depressed population predict self-monitoring behavior may help future studies identify additional interventions and strategies to address self-monitoring barriers.

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Table 1

Baseline participant characteristics

Variable	**Mean (SD) or N (%), n=191**	**Range**
Age (years)	57.99 (8.079)	(36—75)
BMI (kg/m^2)	33.97 (4.405)	(27.0—45.2)
Weight (kg)	90.92 (14.104)	(65.05—137.60)
PHQ-9 Score	4.00 (3.674)	(0—17.0)
Education Level		
High School	42 (22.0%)	
Some College	80 (41.9%)	
Bachelor's Degree	39 (20.4%)	
Master's/Doctoral Degree	30 (15.7%)	
Marital Status		
Married/Cohabitating	164 (85.9%)	
Single/Divorced	17 (8.9%)	
Widowed	10 (5.2%)	
Currently Employed		
Yes	137 (71.7%)	
No	54 (28.3%)	
Years Since End of Treatment	3.41 (2.39)	
Radiation Treatment		
Yes	138 (72.3%)	
No	53 (27.7%)	
Chemotherapy Treatment		
Yes	129 (67.5%)	
No	62 (32.5%)	

Table 2

Weekly average self-monitoring consistency over time by intervention arm

	Weight Loss Phase			Weight Maintenance Phase				
Treatment Arm	Weeks 2-13 M % (SD)	Weeks 14-26 M % (SD)	Total Weeks M% (SD)	Weeks 27-39 M% (SD)	Weeks 40-52 M% (SD)	Weeks 53-65 M% (SD)	Weeks 66-78 M% (SD)	Total Weeks M% (SD)
Phone (n=92)	95.45% (11.32%)	88.13% (20.50%)	91.64% (14.86%)	69.11% (37.63%)	59.87% (43.64%)	53.35% (44.90%)	47.74% (44.34%)	57.52% (39.84%)
Mail (n=99)	95.23% (10.97%)	84.51% (25.75%)	89.64% (17.65%)	58.25% (38.35%)	40.57% (42.42%)	33.17% (41.72%)	28.03% (41.06%)	40.00% (38.00%)
Combined (n=191)	95.34% (11.11%)	86.26% (23.38%)	90.60% (16.35%)	63.48% (38.29%)	49.87% (43.98%)	42.89% (44.34%)	37.52% (43.63%)	48.44% (39.78%)

The weight loss phase occurred during the first 6 months and the intervention ended at the end of these 6 months. Weeks were divided into 12-week time points, generating 6 time points in total. The first time point consists of 11 weeks as data collection did not occur during the first week.

Table 3

Linear Regression of Weekly average self-monitoring consistency predicting weight loss at six months

Coefficients	B_i	**Standard Error**	t	*p*
Intercept	0.2901	2.1185	0.137	0.891
Self-monitoring consistency(B_1)	0.5468	0.1001	5.465	<0.001

R^2=0.13, F (2,189) =29.87, p<0.001

Table 4

Multilevel growth model fixed effects during weight maintenance phase (n=191)

	B_i	Estimated Standard Error	df	*t*	*p*
Intercept (*b*)	84.43	1.55	236.1	54.18	<0.001
Self-monitoring (B_1)	-0.59	0.063	271.9	-9.48	<0.001
Treatment Arm (B_2)	-7.24	2.71	405.5	-2.68	0.0077
Treatment Arm x Time (B_3)	1.58	0.66	338.2	2.4	0.017
Self-monitoring x Treatment Arm (B_4)	0.53	0.18	268.1	3.01	0.0029
Self-monitoring x Time (B_5)	0.10	0.035	254.9	3.01	0.0029
Self-monitoring x Treatment Arm x Time (B_6)	-0.13	0.071	348.6	-1.82	0.07

Table 5
Average depressive symptoms at baseline and 6 months predict self-monitoring consistency at 6 months and 18 months

Study Time Point	n	PHQ-9 (1) Mean (SD)	PHQ-9 (2) Mean (SD)	Self-Monitoring Mean (SD)	*β*	Standard Error	*t*	*p*
Baseline (1) to 6 months (2)	189	4.00 (3.67)	2.59 (3.34)	10.42 (1.92)	-0.089	0.037	-2.43	0.02
6 Months (1) to 18 months (2)	167	2.59 (3.34)	3.34 (2.94)	5.81 (4.77)	-0.39	0.12	-3.15	0.002

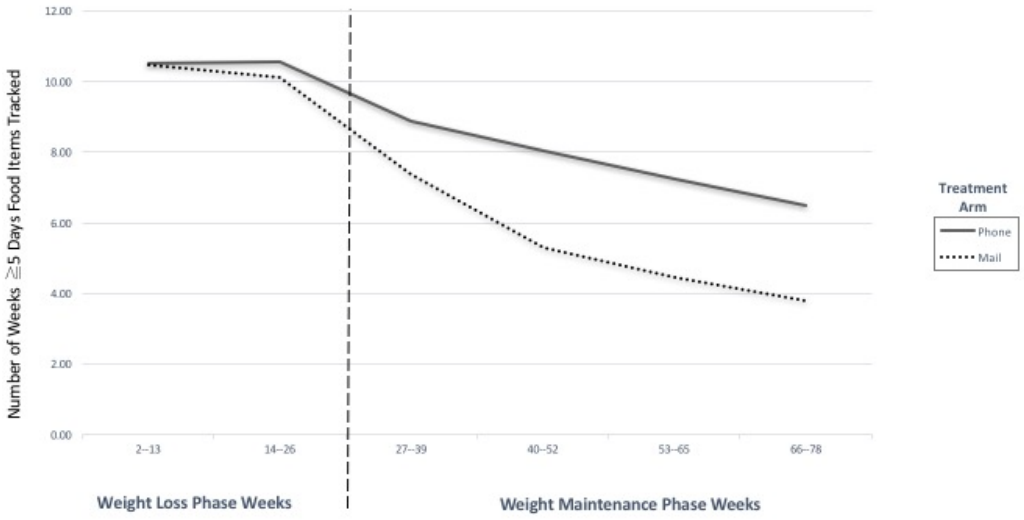

Figure 1. Weekly average self-monitoring consistency across the weight loss and weight maintenance phases by treatment arm.