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Longitudinal weight loss patterns and their behavioral and demographic associations

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Abstract

Background—Identification of weight change patterns may allow tailored interventions to improve long-term weight loss.

Purpose—To identify patterns of weight change over 18 mos., and assess participant characteristics and intervention adherence factors associated with weight change patterns in a sample of 359 overweight/obese adults.

Methods—Weight loss (0–6 mos.) was achieved with reduced energy intake and increased physical activity (PA). Maintenance (7–18 mos.) provided adequate energy to maintain weight and continued PA.

Results—Latent profile analysis identified 3 weight change profiles. During weight loss/maintenance, participants in profiles 2 and 3 (18 mos. weight loss ~14%) attended more behavioral sessions, and performed more PA, compared with profile 1 (18 mo. weight loss <1%). Self-efficacy for both weight management and exercise barriers were higher in profiles 2 and 3 compared with profile 1 following weight loss and during maintenance.

Conclusion—Weight change patterns can be identified and are associated with both participant characteristics and intervention adherence.

Keywords

weight management; self-efficacy; weight maintenance

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Introduction

Approximately 69% of US adults are overweight or obese (BMI ≥ 25 kg/m²); a prevalence rate which has been essentially unchanged over the past decade (1). Behavioral weight loss interventions result in clinically significant weight loss (5–10%) which is maximal at 6 months, followed by weight regain such that 35% to 60% of participants maintain a weight loss of $\geq 5\%$ of baseline body weight at 2 year's follow-up (2). The inter-individual variability in both the short (6 months) and longer term (≥ 1 year) response to behavioral weight loss interventions is large (3). The identification of patterns of individual weight change over time, and factors associated with those patterns, would allow for the development of tailored interventions which may reduce inter-individual variability and generally improve long-term weight loss. However, the literature on this topic is limited and has employed a variety of approaches to identify weight change patterns, diverse samples, and considered a limited number of behavioral factors. These include cluster analysis (4), principal components analysis (5, 6), and latent class analysis (7) over time frames ranging from 12 weeks (4) to 2 years (7). Samples have been comprised of African American women (7), individuals with type 2 diabetes (5, 6), or in a high proportion of individuals with pre-diabetes and/or metabolic syndrome (4). Previous studies have generally focused on the impact of baseline participant characteristics such as weight, personality traits or other psychosocial variables (i.e., self-efficacy, intentions, etc.) on short-term weight loss, with less emphasis on the impact of these factors and other factors, such as participant behavior (e.g., intervention adherence) (8, 9), on long-term weight loss.

Data from our recently completed 18 month randomized equivalence trial, which compared identical behavioral weight management interventions delivered by traditional face-to-face group meetings or by phone conference calls (10), provided an opportunity to evaluate long-term patterns of weight change and factors associated with weight change patterns in a sample of overweight and obese middle-age adults. Specifically, the objectives of these analyses were to (a) identify patterns of weight change over 18 months, and (b) to assess the association of baseline participant characteristics (age, sex, race/ethnicity, intervention group, household income, self-efficacy for exercise barriers and weight management) and intervention adherence factors (behavioral sessions completed, compliance with the diet and exercise program, weekly data reports completed) with weight change pattern. These variables were selected based on a previously demonstrated association with the weight change response to behavioral weight loss interventions (8, 11–14).

Methods

Data for this report are from a two arm randomized controlled equivalence trial designed to compare identical behavioral weight loss interventions delivered either by traditional face-to-face group meetings or by group phone conference calls over 18 months (6 months weight loss; 12 months maintenance; NCT01095458). A detailed description of the study design, including inclusion/exclusion criteria, and results for the primary outcomes have been published (10, 15). Briefly, results indicated clinically significant and equivalent weight loss at both 6 and 18 months for the face-to-face (6 mos. = -13.4% , 18 mos. = -8.5%) and phone groups (6 mos. = -12.3% , 18 mos. = -7.4%). However, there was

considerable inter-individual variability in weight change with 26% of participants losing < 5% and ~35% of participants losing 10% from baseline to 18 months.

Participants

Participants were overweight and obese men and women (age 18–65 yrs., BMI 25–44.9 kg·m²) who were willing to be randomized to one of the two study groups and provided physician consent to participate in a weight loss intervention. Written informed consent was obtained prior to engaging in any aspect of this trial. Financial compensation was provided for completing outcome assessments. Approval for this trial was obtained from the Human Subjects Committee at the University of Kansas-Lawrence.

Intervention

Behavioral sessions, based on Social Cognitive Theory (16) with groups of 11–12 participants were conducted weekly during the weight loss phase (month 0 to 6, 24 total sessions), and tapered during weight maintenance to twice per month during months 7–9, monthly during (months 10–12, 9 total sessions), and every other month for the remainder of the 18 month trial (3 total sessions). Sessions were conducted by trained health educators who maintained attendance records for all sessions. Energy intake was reduced to ~1200 to 1500 kcal/day during weight loss using a combination of commercially available portion controlled meals (HMR Weight Management Service) that were provided free of charge as part of the study and self-purchased fruits and vegetables, and non-caloric beverages. Portion controlled, pre-packaged entrées were shelf-stable and required heating in a microwave prior to consumption. Participants were instructed to consume a minimum of 2 entrées/day (14/week) (140 – 270 kcal each), 3 shakes/day (21/week) (100 kcal each), and at least five, 1-cup servings of fruits or vegetables/day (35/week). Non-caloric beverages such as diet soda, coffee, etc. were allowed ad libitum. The combination of entrées, shakes and fruits and vegetables provided a nutritionally adequate diet in accordance with USDA guidelines (www.mypyramid.gov). During weight maintenance (months 7–18) participants were provided a meal plan with suggested servings of grains, proteins, fruits, vegetables, dairy, and fats, based on their energy needs for weight maintenance and the USDA's 2005 "My Pyramid" (www.mypyramid.gov). Energy intake for weight maintenance was calculated using the equation of Mifflin et al (17) and adjusted as needed based on subsequent weight change. Participants were strongly encouraged, but not required, to continue consuming a minimum of 14 portion controlled meals, either entrées or shakes, and 35 servings of fruits and vegetables per week during weight maintenance. A physical activity program was prescribed which progressed from 45 min/wk. (3–15 min. sessions) to 300 min/wk. (5– 60 min sessions) across the initial three months and remained at 300 min/wk. for the remainder of the study. Pedometers were provided to monitor daily steps (Accusplit Eagle 120XLE). Participants in each group reported the number of portion controlled meals, servings of fruits and vegetables, and physical activity (minutes and steps) to their health educators each week across the 18-month intervention. During weight loss (0–6 mos.) data was reported at weekly behavioral sessions. Participants unable to attend behavioral sessions were asked to submit data via phone call, fax, or e-mail to the health educator as soon as possible. During weight maintenance (7–18 mos.) weekly data was

submitted either at behavioral sessions or by phone, fax, or email depending on the behavioral session schedule.

Measures

The following assessments were obtained at 0, 6, 12, and 18 months by trained research assistants blinded to group assignment.

Weight, height

Body weight was assessed using a digital scale accurate to ± 0.1 kg (Befour Inc Model #PS6600, Saukville, WI). Weight was obtained between the hours of 6 and 10 am, prior to breakfast, after attempting to void, with participants wearing a standard hospital gown. Height was measured using a stadiometer (Model PE-WM-60-84, Perspective Enterprises, Portage MI). Body mass index was calculated as weight (kg) divided by height (m^2).

Barriers to Exercise

Self-efficacy for overcoming barriers to exercise was assessed using the 5-item questionnaire described by Marcus & Owen (18). Participants rated confidence in their ability to participate in exercise when: tired, in a bad mood, don't feel they have time, when on vacation, and when there is inclement weather using an 11 point Likert scale ranging from "not at all confident" to "very confident". Chronbach's alphas, as a measure of internal consistency, were 0.85 and 0.80 in samples of middle-age adults in the US, and Australia, respectively (18, 19).

Weight management self-efficacy

Self-efficacy for weight management was assessed using the Weight Efficacy Life-Style Questionnaire (WEL) (20). The WEL consists of 20 items that are clustered in 5 domains: Negative Emotions (e.g., I can resist eating when I am anxious (nervous), Food Availability (e.g., I can resist eating even when I am at a party), Social Pressure (e.g., I can resist eating even when I feel it's impolite to refuse a second helping), Physical Discomfort (e.g., I can resist eating when I feel physically run down), and Positive Activities (e.g., I can resist eating just before going to bed.). Items are scored on a 10-point Likert scale from 0 (not confident) to 9 (very confident). Subscale scores were summed to calculate the total WEL score. Chronbach's alpha ranged from 0.70 to 0.90 over the 5 domains assessed (20).

In addition, we estimated average annual household income, based on participants self-reported residence zip code, using data from the 2010 U.S. Census (21).

Statistical Analysis

Latent profile analysis (22) was used to identify subgroups (profiles) of participants based on changes in body weight assessed following the completion of weight loss (6 mos.) and during (12 mos.) and at the completion of weight maintenance (18 mos.). Latent profile analysis postulates that the correlations among observed continuous variables may be explained by the existence of a categorical latent variable representing a few mutually exclusive subgroups within the population. The advantages of this approach over cluster

analysis include the following: latent profile analysis is (a) model based; (b) allows generation of probabilities for group membership, and (c) tests goodness-of-fit across competing models. A series of mixture models (1-to 4-class models) were fitted to the percent weight change (6, 12 and 18 mos.). The fitted models were compared by average classification posterior probability (ACPP; (23), Akaike Information Criteria (AIC; (24) and adjusted Bayesian Information Criterion (aBIC; (25), entropy (26, 27), and the Vuong–Lo–Mendell–Rubin (VLMR; (28)) and adjusted Lo–Mendell–Rubin likelihood ratio tests (aLMR; (29)). Both likelihood ratio tests compared a k -profile model with a $k-1$ -profile model. A significant p value suggests that a $k-1$ -profile model should be rejected in favor of a k -profile model. Membership in one of the identified profiles was based on the Bayesian posterior probabilities. The marginal class means, derived via posterior probability-based multiple imputations, for participant characteristics, intervention adherence assessed by clinic attendance, and adherence to the diet and physical activity prescriptions, and barriers to exercise and weight management self-efficacy at 6, 12 and 18 mos. were compared between the identified profiles using Chi-square tests (30). Participant characteristics included age, sex, weight, BMI, race/ethnicity, intervention group, and self-efficacy for both overcoming barriers to exercise, and weight management. All comparisons were Bonferroni-corrected for inflation in Type I error. Statistical significance was determined at 0.05 alpha level. All analyses were performed using *Mplus* version 7 (Muthén & Muthén, Los Angeles, CA) and SAS version 9.4 (SAS Institute Inc., Cary, NC).

Results

The study sample consisted of 359 overweight and obese (BMI ~ 35 kg·m²) adults (44 yrs.); 22% minorities, 67% women (Table 1) and represents 91% of those randomized at baseline with data on all variables included in this analysis.

Latent Profile Analysis

Model fit values and likelihood ratio test results from each of the 1- to 4-profile models are shown in Table 2. In general, ACPPs indicated good classification quality of each model, with the highest values (0.94) observed for the 2- and 3-profile models. The 3-profile model produced the highest entropy value (0.85), thus the smallest classification error. VLMR and aLMR likelihood ratio tests also suggested that three profiles were optimal, with significant p values for the 2- and 3-profile models, and a non-significant p value for the 4-profile model. AIC and aBIC indicated better fit for the models with more profiles. However, it is important to note that both AIC and aBIC tend to overestimate the number of profiles (30–33); and the fit improvement (i.e., decrease in AIC and aBIC) was minimal for the 4-class, compared to either the 2- or 3-profile models. When all results are considered, the latent profile analysis suggested that there are 3 profiles for change in weight over 18 months (Figure 1). These profiles can be described as: 1) modest loss (–7% at 6 mos.) - complete regain (–0.3% at 18 mos.) ($n = 162$, 45.1% of the sample); 2) intermediate loss (–14% at 6 mos.) - minimal regain (–8.5% at 18 mos.) ($n = 132$, 36.8% of the sample); 3) substantial loss (–22% at 6 mos.) - minimal regain (–19% at 18 mos.) ($n = 65$, 18.1% of the sample).

Association of baseline characteristics and weight change profile (Table 1). Participants in the two profiles with clinically significant weight loss at 18 months (profiles 2 and 3) were significantly older at baseline compared with participants whose weight at 18 months was essentially unchanged from baseline (profile 1). The percentage of minority participants was significantly higher in profile 1 compared with profile 3. There were no significant baseline differences between any of the 3 weight change profiles for weight, BMI, annual household income, self-efficacy for exercise barriers or weight management, sex, or intervention group.

Association of intervention adherence and weight change profile during weight loss (mos. 0–6) (Table 3). Participants in profiles 2 and 3 attended more behavioral sessions, completed more weekly data reports, consumed greater numbers of entrees and shakes, and recorded higher levels of physical activity compared with those in profile 1. However, there was no significant difference in weekly fruit/vegetable consumption between profiles 1 and 2. Participants in profile 3 attended significantly more behavioral sessions, completed more weekly data reports, and consumed greater numbers of entrées, shakes and fruits/vegetables compared with participants in profile 2. There were no significant differences between profiles 2 and 3 for physical activity.

Association of intervention adherence and weight change profile during weight maintenance (mos. 7–18). (Table 3). Participants in profiles 2 and 3 attended significantly more behavioral sessions, completed more weekly data reports and reported higher levels of physical activity compared with those in profile 1. There were no significant differences between profiles in consumption of entrées and shakes during weight maintenance. The consumption of fruits/vegetables was significantly higher in profile 3 compared with both profiles 1 and 2.

Association between self-efficacy for overcoming exercise barriers and weight change profile (Table 3). Self-efficacy for overcoming exercise barriers was significantly higher at 6, 12, and 18 months in profiles 2 and 3 compared with profile 1. There was no significant difference between profiles 2 and 3 at 6 months; however, self-efficacy for overcoming exercise barriers was significantly higher in profile 3 compared with profile 2 at 12 and 18 months.

Association between self-efficacy for weight management and weight change profile (Table 3). Self-efficacy for weight management was significantly higher at 6, 12, and 18 months in profiles 2 and 3 compared with profile 1. Self-efficacy for weight management was significantly higher in profile 3 compared with profile 2 at 12 months but not at 6, and 18 months.

Discussion

Latent profile analysis identified three distinct profiles of weight change over an 18 month behavioral weight management intervention (6 mos. weight loss, 12 mos. maintenance) in a sample of overweight and obese middle-age adults. Participants in profile 1, comprising 45% of the sample, achieved clinically significant weight loss at 6 months (7%); however, lost weight was regained at 18 months. In contrast, participants in profiles 2 and 3, who

comprised 55% of the sample, achieved a mean weight loss of 18% at 6 months, and although some weight was regained, mean weight loss at 18 months remained 14% below baseline.

Direct comparison of our results regarding patterns of weight change with other reports in the literature are problematic due to the wide variations in the type (e.g., conventional meal plan, portion controlled meals, etc.) and length (1 to 4 yrs.) of behavioral interventions, health status of participants, and type of analytic approaches applied (cluster, principle component, or latent profile analysis) (4–7). Despite differences in intervention length, frequency of contact, type of diet etc., several previous studies have identified distinct patterns of weight change over time, in general agreement with our results; however, the exact patterns of weight change vary across studies. For example, Espeland et al (6) used principal components analysis to describe weight change patterns over 12 months in 2,485 participants enrolled in the lifestyle arm of the Look AHEAD trial which utilized a conventional diet. Three components were identified which accounted for 97% of the total intra-participant variance: weight loss that gradually decelerated over time (88.8%), weight loss occurring early or late (6.6%) and weight loss which was maximal during months 4–8 (1.6%). Yank et al (4) used cluster analysis to identify patterns of weight change over 12 weeks in a primary care-based translation of the Diabetes Prevention Program (DPP) lifestyle intervention which used a conventional diet. The sample included 62 overweight/obese ($\text{BMI} = 31.9 \text{ kg/m}^2$), adults (age = 55 yrs.), 90% with metabolic syndrome and 56% with pre-diabetes. Three weight loss patterns were identified: modest (4% $n = 15$), moderate-and-steady (7%, $n = 43$), and substantial-and-early (9%, $n = 14$). The identification of distinct patterns of weight change in response to weight loss/maintenance interventions appears to be a robust finding in that it is observed regardless of differences in intervention characteristics, such as length, frequency of contact, diet mode etc., or analytic technique employed (e.g., principal components, cluster or latent profile analysis).

Our observation that those who were most successful at achieving clinically significant weight loss over 18 months were older (+3.5 years), and less likely to be minorities, is consistent with other reports in the literature (11, 34). For example, one year results from the Look AHEAD trial suggested significantly greater weight loss in the oldest participants (65–74 yrs.) and in non-Hispanic whites; however, the clinical significance of differences were questioned as weight loss across age groups varied by only 1.5%, and weight losses of > 5% were observed in all race/ethnic groups (11). At the 4-year follow-up, weight loss in the oldest participants in the Look AHEAD trial was significantly greater than their younger counterparts; however, no significant differences in weight loss between race/ethnic groups were reported. Reasons for the diminished weight loss response in ethnic minorities and younger individuals, observed in this and other trials, are unclear and suggests that traditional approaches to weight management may not be appropriate for these groups (35). Some reports have suggested better weight loss in men compared with women (36, 37) while others have not (11). In the current trial there were no significant differences in the sex distribution across weight change profiles.

Participants in profiles exhibiting the largest weight loss (profiles 2 and 3) during the weight loss phase (0–6 mos.) attended more behavioral clinic sessions and adhered to all

components of the diet and physical activity prescriptions, a finding in agreement other reports (8, 11, 38, 39). During weight maintenance (7–18 mos.) we observed no differences between weight change profiles in the consumption of entrées or shakes; however, the consumption of fruits and vegetables was significantly higher in profiles exhibiting clinically significant long-term weight loss (profiles 2 and 3) compared with profile 1. Others have also reported an association between fruit and vegetable consumption and improved weight loss maintenance (40–42). For example, Howard et al (42) reported increased servings of fruits and vegetables were associated with greater weight loss over 7.5 years in a sample of post-menopausal women in the Women’s Health Initiative Dietary Modification Trial. During weight maintenance physical activity was significantly higher in profiles exhibiting clinically significant long-term weight loss (profiles 2 and 3) compared with profile 1. Associations between higher levels of physical activity and weight maintenance have been well documented in observational studies such as the National Weight Control Registry (43, 44). However, results from randomized trials on the association between increased physical activity and improved weight maintenance are inconsistent (45–47).

We found no significant differences in self-efficacy for exercise barriers between the 3 weight loss profiles at baseline; however, self-efficacy for exercise barriers across the intervention was significantly higher in profiles 2 and 3 compared with profile 1. Some previous studies have shown an association of baseline self-efficacy for exercise and improved weight loss (48–50) while others have not (51, 52). Increased exercise self-efficacy during a behavioral intervention has also been associated with improved weight loss in several trials (13, 51, 52).

The results for self-efficacy for weight management were similar to those for self-efficacy for exercise barriers. That is, we found no significant differences in self-efficacy for weight management between the 3 weight loss profiles at baseline; however, self-efficacy for weight management across the intervention was significantly higher in profiles 2 and 3 compared with profile 1. The finding of no baseline differences in self-efficacy for weight management between weight loss profiles is consistent with some reports (51, 53, 54); however several reports have shown higher baseline self-efficacy for weight management/eating behavior to be associated with improved weight loss during treatment and at follow-up (48–50, 52, 55–57). Inconsistent results regarding the association of both exercise and weight management self-efficacy and weight loss are at least partially a function of differences in the length and type of the weight loss/maintenance, the type of self-efficacy measure utilized interventions, and participant demographic characteristics. Several previous trials have reported an association between improved self-efficacy for weight management, resulting from a behavioral intervention, and improved weight loss (13, 52, 53, 56–58). In the current study we found no significant difference in self-efficacy for weight management between weight change profiles at baseline. However, self-efficacy for weight management across the intervention (i.e., at 6, 12, & 18 mos.) was significantly higher in profiles 2 and 3 compared with profile 1 suggesting that improved, or not reduced self-efficacy for weight management, was associated with greater weight loss. The observed differences in changes in self-efficacy for both exercise barriers and weight management across the intervention between the most (profile 1) and least successful profiles (profile 3) are potentially

informative. In profile 1, self-efficacy for exercise barriers decreased 12% from baseline to the end of weight loss (6 months) and was 19% below baseline at the end of weight maintenance (18 months). In contrast, in profile 3, self-efficacy for exercise barriers was unchanged following weight loss, and decreased only 2% below baseline at 18 months. Self-efficacy for weight management in profile 1 was essentially unchanged following weight loss but was 12% below baseline at 18 months. However, self-efficacy for weight management following weight loss in profile 3 was 8% higher than baseline and was 6% higher than baseline at 18 months. Decreased self-efficacy seen in profile 1, which may be associated with poor long-term weight loss, suggests that a substantial portion of participants (45% in this trial) may need alternative treatments to achieve clinically significant weight loss and maintenance.

Mean weight loss following the weight loss phase (mos. 0–6), was greater in the profiles with clinically significant weight loss at 18 mos. (profiles 2 and 3) compared profile 1. This observation is in agreement with numerous reports suggesting an association between greater initial weight loss and long-term success in response to both behavioral interventions alone (5, 9, 12, 14, 59–64) or when behavioral interventions are combined with weight loss medications (65, 66). For example, results from the Look AHEAD trial indicated weight loss at 1-year was a strong determinant of 4-year weight loss (61). In the DPP lifestyle intervention, participants with weight loss of at least 7% from baseline to the end of the core curriculum (24 wks.) were 3 times more likely to achieve a 7% weight loss at the final visit (~3.2 yrs.) compared to those with 24 week weight loss < 7% (60). Studies have also shown that weight loss relatively early in a weight loss intervention (i.e. 3 months) is associated with weight loss success at 1-year (4, 62–64). For example, in 2327 adults with type 2 diabetes randomized to the intensive lifestyle intervention of the Look AHEAD trial, those failing to achieve a 2% weight loss at month 1 were 5.6 times more likely not to achieve a 10% weight loss at year 1, compared with those losing 2% at month 1 (64). In a primary care based translation of the DPP lifestyle intervention Yank et al (4) reported that only participants who lost 5% of baseline weight at 3 months were able to maintain this weight loss at 15 months. Smith et al (66) combined data from 3 separate phase 3 trials of lifestyle modification plus Locaserin (n= 6897) in adults. Results indicated that weight loss > 5% at week 12 was a strong predictor of weight loss at 1 year in adults with and without type 2 diabetes. Our results, and those in the literature, suggest that the first few months of a weight loss intervention may be an opportune time to identify individuals who are unlikely to be successful with short or long-term weight loss, and institute rescue strategies to increase the probability of success. However, to date, rescue strategies, sometimes referred to as a “stepped care” approach, have generally been unsuccessful in improving both short and long-term weight loss (67–70). Questions regarding the optimal time and magnitude of weight loss for the identification of participants likely to be unsuccessful, and the type and intensity of rescue strategies associated with successful short and long-term weight loss, are important areas for additional investigation.

Strengths of this study include a relatively large sample of overweight and obese adults, an intervention delivered and closely monitored by trained health educators, and the inclusion of outcome assessments following weight loss and during and following weight maintenance. This secondary analysis was limited to variables included in the primary data

set plus household income estimated from census data. Several variables which may have provided additional insight into differences between weight change profiles such as cognitive restraint, uncontrolled eating, emotional eating, social support, the number of previous weight loss attempts etc. were unavailable. Additionally, our results are based on overweight and obese adults who volunteered, and were financially incentivized to participate in a weight loss/maintenance trial and thus may not generalize to other settings, participant groups, time frames (e.g., > 1 year), or behavioral intervention strategies.

Summary

Latent profile analysis identified three distinct profiles of weight change over an 18-month behavioral weight management intervention (6 mos. weight loss, 12 mos. maintenance) in a sample of overweight and obese middle-age adults. Participants in profile 1 achieved clinically significant weight loss at 6 months (7%); however, this profile regained their lost weight at 18 months. In contrast, participants in profiles 2 and 3 achieved a mean weight loss of 18% at 6 months, and although some of the lost weight was regained, mean weight at loss at 18 months remained 11–14% below baseline. Participants in the two profiles with clinically significant weight loss over 18 months were less likely to be minorities, were older, displayed better adherence to components of both the weight loss and weight maintenance interventions, and had higher levels of self-efficacy for weight management and exercise barriers compared to participants who failed to achieve long-term weight loss. Our findings contribute to the accumulating evidence suggesting the importance of the magnitude of initial weight loss for successful long-term weight management. Additional research to evaluate the optimal time and magnitude of weight loss for the identification of participants likely to be unsuccessful, and the type and intensity of rescue strategies associated with successful short and long-term weight loss, as well as strategies to improve weight management in younger individuals and in minority groups are warranted.

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Figure 1.
Patterns of weight change over an 18 month weight management intervention (6 mos. weight loss, 12 mos. weight maintenance) identified by latent profile analysis

Table 1

Baseline characteristics: Total sample and by weight change profiles.

Variable	Total Sample (n=359)	Profile 1 (n=162) Modest loss- Complete regain	Profile 2 (n = 132) Intermediate loss- Minimal regain	Profile 3 (n = 65) Substantial loss- Minimal regain	Profile 1 vs. Profile 2		Profile 1 vs. Profile 3		Profile 3 vs. Profile 2	
					χ^2	p	χ^2	p	χ^2	p
Age (yrs.)	44.4 (0.5)	42.3 (0.8)	45.9 (0.9)	46.7 (1.1)	8.4	<0.01	10.0	<0.01	0.3	0.57
Female (%)	66.6	72.1 (3.7)	62.3 (4.6)	61.2 (6.1)	2.6	0.11	2.3	0.13	0.0	0.89
Minority (%)	22.0	26.3 (3.7)	20.2 (3.7)	15.0 (4.5)	1.3	0.25	3.9	0.05	0.8	0.38
Annual household income (\$)	43,767 (753)	44,485 (1,272)	43,928 (1,288)	41,777 (1,500)	0.1	0.77	1.9	0.17	1.1	0.29
Intervention Group (%FTF)	56.0	46.0 (4.1)	51.0 (4.8)	54.2 (6.3)	0.6	0.45	1.2	0.27	0.2	0.69
Weight (kg)	100.2 (1.0)	99.9 (1.4)	99.6 (1.8)	101.9 (2.5)	0.0	0.90	0.5	0.49	0.5	0.47
BMI (kg/m ²)	34.7 (0.3)	35.1 (0.4)	34.1 (0.5)	34.6 (0.5)	2.1	0.15	0.6	0.44	0.4	0.55
Self-Efficacy- Exercise Barriers (range = 0–10)	8.5 (0.1)	8.5 (0.1)	8.5 (0.2)	8.6 (0.3)	0.0	0.87	0.0	0.92	0.0	0.83
Self-Efficacy- Weight Management (range = 0 – 180)	142.6 (1.5)	142.9 (2.2)	143.4 (2.6)	140.0 (3.7)	0.0	0.89	0.5	0.49	0.6	0.45

Values are mean (standard error).

¹ Profile 1 vs. Profile 2² Profile 1 vs. Profile 3³ Profile 3 vs. Profile 2

FTF = Face-to-face group meetings

Table 2**Model Fit Estimates and Likelihood-Ratio Test Results**

Model	ACPP	AIC	aBIC	Entropy	VLMR (p)	aLMR (p)
1-class	NA	6236.1	6240.3	NA	NA	NA
2-class	0.94	5837.1	5846.4	0.82	<0.01	<0.01
3-class	0.94	5567.3	5581.5	0.85	<0.0001	<0.0001
4-class	0.89	5486.7	5505.9	0.80	0.34	0.35

ACPP = Average Classification Posterior Probability

AIC = Akaike Information Criteria

aBIC = adjusted Bayesian Information Criterion

VLMR = Vuong–Lo–Mendell–Rubin likelihood ratio test

aLMR = adjusted Lo–Mendell–Rubin likelihood ratio test.

NA = not applicable

Table 3

Comparison of intervention adherence, self-efficacy for overcoming exercise barriers and self-efficacy for weight management between weight change profiles.

Variable	Profile 1 (n =162)	Profile 2 (n = 132)	Profile 3 (n =65)	Profile 1 vs. Profile 2		Profile 1 vs. Profile 3		Profile 3 vs. Profile 2	
	Modest loss- Complete regain	Intermediate loss- Minimal regain	Substantial loss- Minimal regain	χ^2	p	χ^2	p	χ^2	p
Intervention Adherence									
0–6 months									
Behavioral sessions attended	16.0 (47.2) [66.7%]	19.3 (34.5) [80.4%]	21.3 (29.5) [88.8%]	29.2	<0.0001	89.6	<0.0001	18.5	<0.0001
Weekly data reports completed	19.9 (0.5) [82.9%]	22.8 (0.2) [95.0%]	23.6 (0.2) [98.3%]	27.8	<0.0001	52.7	<0.0001	5.6	0.02
Entrées (#/wk.)	12.1 (0.1) [86.4%]	12.5 (0.1) [89.3%]	12.9 (0.1) [92.1%]	5.3	0.02	18.9	<0.0001	5.3	0.02
Shakes (#/wk.)	17.7 (0.2) [84.2%]	18.3 (0.2) [87.1%]	19.2 (0.2) [91.4%]	3.7	0.05	23.9	<0.0001	8.9	<0.01
Fruits/vegetables (servings/wk.)	39.6 (0.7) [113.1%]	39.6 (0.7) [113.1%]	42.3 (1.0) [120.8%]	0.0	0.98	4.6	0.03	4.2	0.04
PA (min./wk.)	190.4 (7.2) [63.4%]	226.2 (8.7) [75.4%]	242.0 (7.8) [80.6%]	9.0	<0.01	24.4	<0.0001	1.8	0.18
PA (steps/wk.)	54,868 (1,625)	60,872 (1,415)	64,420 (2,115)	7.0	<0.01	12.9	<0.0001	1.9	0.17
7–12 months									
Behavioral sessions attended	4.1 (0.3) [45.5%]	5.1 (0.2) [56.6%]	6.0 (0.3) [66.7%]	7.4	<0.01	26.8	<0.0001	6.5	0.01
Weekly data reports completed	16.9 (0.7) [70.4%]	18.7 (0.7) [77.9%]	21.4 (0.6) [89.1%]	3.3	0.07	22.1	<0.0001	8.2	<0.01
Entrées (#/wk.)	6.0 (0.5) [85.7%]	5.6 (0.4) [80.0%]	6.2 (0.5) [88.5%]	0.6	0.43	0.1	0.75	1.4	0.24
Shakes (#/wk.)	6.7 (0.6) [95.7%]	6.2 (0.5) [88.5%]	7.2 (0.6) [102.8%]	0.5	0.50	0.4	0.53	1.8	0.18
Fruits/vegetables (servings/wk.)	34.9 (1.2) [99.7%]	35.7 (0.9) [102.0%]	41.1 (1.3) [117.4%]	0.3	0.61	12.4	<0.0001	11.7	<0.001
PA (min./wk.)	196.0 (11.1) [65.3%]	232.2 (9.6) [77.4%]	266.7 (8.2) [88.9%]	5.5	0.02	26.1	<0.0001	7.3	<0.01
PA (steps/wk.)	56,846 (1,952)	61,974 (1,473)	67,860 (2,289)	4.0	0.04	13.4	<0.0001	4.6	0.03
13–18 months									
Behavioral sessions attended	1.4 (0.2) [46.6%]	2.6 (0.3) [86.6%]	3.0 (0.4) [100.0%]	10.3	<0.001	15.4	<0.0001	1.1	0.30
Weekly data reports completed	15.1 (1.0) [62.9%]	17.8 (0.8) [74.2%]	20.5 (0.7) [85.4%]	4.2	0.04	19.9	<0.0001	6.2	0.01
Entrées (#/wk.)	4.0 (0.5) [57.1%]	3.6 (0.4) [51.4%]	4.7 (0.5) [67.1%]	0.2	0.63	1.0	0.31	2.6	0.11
Shakes (#/wk.)	2.7 (0.5) [38.6%]	2.3 (0.4) [32.8%]	3.7 (0.6) [52.8%]	0.1	0.82	1.5	0.22	2.2	0.14
Fruits/vegetables (servings/wk.)	30.5 (1.3) [87.1%]	33.0 (0.9) [94.3%]	39.0 (1.3) [111.4%]	2.3	0.13	21.9	<0.0001	14.4	<0.0001
PA (min./wk.)	157.9 (11.4) [52.6%]	199.5 (11.3) [66.5%]	237.5 (10.8) [79.2%]	6.2	0.01	25.7	<0.0001	5.8	0.02
PA (steps/wk.)	52,055 (2,543)	57,983 (1,780)	64,730 (2,740)	3.4	0.07	11.5	<0.001	4.2	0.04

Variable	Profile 1 (n =162) Modest loss- Complete regain	Profile 2 (n = 132) Intermediate loss- Minimal regain	Profile 3 (n =65) Substantial loss- Minimal regain	Profile 1 vs. Profile 2		Profile 1 vs. Profile 3		Profile 3 vs. Profile 2	
				χ^2	p	χ^2	p	χ^2	p
Self-efficacy: exercise barriers									
6 months	7.5 (0.2)	8.4 (0.2)	8.6 (0.2)	15.1	<0.0001	19.4	<0.0001	0.5	0.50
12 months	6.2 (0.2)	7.7 (0.2)	8.6 (0.2)	17.7	<0.0001	53.8	<0.0001	8.1	<0.01
18 months	6.1 (0.2)	7.4 (0.2)	8.4 (0.3)	15.1	<0.0001	43.2	<0.0001	7.6	<0.01
Self-efficacy: weight management									
6 months	142.3 (1.9)	149.4 (2.0)	154.1 (2.2)	6.1	0.01	16.3	<0.0001	2.4	0.12
12 months	125.4 (2.8)	139.6 (3.0)	149.4 (2.9)	11.5	<0.001	35.9	<0.0001	5.5	0.02
18 months	125.5 (3.1)	137.4 (2.8)	145.4 (3.3)	7.8	<0.01	19.8	<0.0001	3.3	0.07

Values are mean (standard error)[% of recommendation].

PA = Physical Activity