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Cluster Analysis of the National Weight Control Registry to Identify Distinct Subgroups Maintaining Successful Weight Loss

Lorraine G. Ogden[1,2], **Nanette Stroebele**[1], **Holly R. Wyatt**[1,3], **Victoria A. Catenacci**[1,3], **John C. Peters**[1,3], **Jennifer Stuht**[1], **Rena R. Wing**[4], and **James O. Hill**[1,5]

[1]Colorado Center for Health and Wellness, University of Colorado Denver, Aurora, Colorado, USA

[2]Department of Biostatistics and Informatics, Colorado School of Public Health, University of Colorado Denver, Aurora, Colorado, USA

[3]Division of Endocrinology, Metabolism and Diabetes, School of Medicine, University of Colorado Denver, Aurora, Colorado, USA

[4]Centers for Behavioral and Preventive Medicine, The Miriam Hospital Medical School, Providence, Rhode Island, USA

[5]Department of Pediatrics, School of Medicine, University of Colorado Denver, Aurora, Colorado, USA

Abstract

The National Weight Control Registry (NWCR) is the largest ongoing study of individuals successful at maintaining weight loss; the registry enrolls individuals maintaining a weight loss of at least 13.6 kg (30 lb) for a minimum of 1 year. The current report uses multivariate latent class cluster analysis to identify unique clusters of individuals within the NWCR that have distinct experiences, strategies, and attitudes with respect to weight loss and weight loss maintenance. The cluster analysis considers weight and health history, weight control behaviors and strategies, effort and satisfaction with maintaining weight, and psychological and demographic characteristics. The analysis includes 2,228 participants enrolled between 1998 and 2002. Cluster 1 (50.5%) represents a weight-stable, healthy, exercise conscious group who are very satisfied with their current weight. Cluster 2 (26.9%) has continuously struggled with weight since childhood; they rely on the greatest number of resources and strategies to lose and maintain weight, and report higher levels of stress and depression. Cluster 3 (12.7%) represents a group successful at weight reduction on the first attempt; they were least likely to be overweight as children, are maintaining the longest duration of weight loss, and report the least difficulty maintaining weight. Cluster 4 (9.9%) represents a group less likely to use exercise to control weight; they tend to be older, eat fewer

Correspondence: Lorraine G. Ogden (Lorri.Ogden@ucdenver.edu).

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meals, and report more health problems. Further exploration of the unique characteristics of these clusters could be useful for tailoring future weight loss and weight maintenance programs to the specific characteristics of an individual.

Introduction

Obesity is recognized as a leading cause of preventable death in the United States, second only to smoking (1). In spite of the magnitude of this disease burden, the great need for weight control, and the existence of a wide variety of popular weight loss remedies, rates of overweight and obesity in the US population continue to increase (2,3). Although a vast amount of research has focused on factors impacting weight loss, far less has focused on factors impacting longterm maintenance of weight loss. This is not surprising given the challenges, cost, and time required for prospective weight loss maintenance studies.

The National Weight Control Registry (NWCR) is an ongoing, observational study of individuals who have achieved longterm success in weight loss maintenance (4,5). Individuals are eligible to join the NWCR if they have maintained a weight loss of at least 30 pounds (13.6 kg) for at least 1 year. The NWCR was founded in 1994 and has continuously accrued individuals over the past 17 years. The number of participants has thus increased each year, with over 5,000 members currently.

Over the past 15 years, researchers have identified common behaviors and strategies used by these successful individuals (5–7). These include: consuming low-energy, low-fat diets; engaging in high levels of physical activity; consistent self-monitoring of body weight and food intake; eating breakfast regularly; and demonstrating a high level of dietary restraint. In addition, with the exception of high dietary restraint, participants in the NWCR do not show higher levels of psychological symptoms (i.e., depression, general emotional distress, binge eating, and self-induced vomiting) than observed in the general population (8).

To date only univariate and bivariate analyses have been conducted on the NWCR database to identify the behaviors and strategies most commonly reported for successful weight loss maintenance and to compare defined groups of participants (e.g., comparing those who lost weight on their own to those utilizing organized programs). Although common behaviors have been identified, there may be subgroups within the registry relying on different behavioral strategies for weight loss and weight loss maintenance. For example, although NWCR entrants report an average of 2,621 kcal/week in physical activity, there is considerable variability in the amount of activity reported, with ~25% reporting <1,000 kcal/week (9). There is thus a subgroup of NWCR participants who report maintaining a significant weight loss with relatively low levels of physical activity. The goal of the current study was to use multivariate latent class cluster analysis to identify unique clusters of individuals within the NWCR that may have distinct strategies, experiences, and/or attitudes regarding weight loss and weight loss maintenance. The cluster analysis also considers factors such as weight and health history, level of effort and satisfaction with maintaining weight, and psychological and demographic characteristics. The characteristics of these clusters could be used to understand how different groups of individuals may use different strategies and have different experiences and attitudes regarding weight, weight loss, and

weight maintenance. This information could be used to develop better programs to assist people in weight loss maintenance by tailoring programs to specific characteristics of the individual.

Methods and Procedures

Subjects

Participants in the NWCR are self-selected and recruitment is done through national and local media resources such as television, radio, newspapers, and magazines. Individuals interested in participating are asked to call a toll-free number or register online. Consent forms and baseline questionnaires are then mailed to these individuals. Participants provide information on their lifetime maximum weight, current weight, and approximate dates at which they were at these weights. This information is used to determine whether they meet the eligibility criteria. For more information on data collection and eligibility criteria see Klem *et al.* (5).

Although baseline data has been collected on over 5,000 individuals, the database selected for the cluster analysis included 2,228 NWCR participants. The participants came from a larger subset of participants who answered a revised and more complete baseline questionnaire from 1998 to 2002.

Measures

Registry members fill out questionnaires collecting demographic and weight-history characteristics, weight-loss methods and strategies, weight maintenance methods and strategies, and the effect of weight loss and weight maintenance on selected aspects of their lives. The sections below describe measures used to assess each of these areas.

Demographic and weight characteristics—All subjects completed a questionnaire requesting standard demographic information (age, education level, marital status) and details about weight history (age at onset of overweight, parental and sibling weight status, maximum lifetime weight, current weight, and duration of the required 30 lb minimum weight loss). Calculations were made to get maximum lifetime body mass index (BMI kg/m^2), current BMI, change in BMI, and change in body weight (maximum lifetime weight − current body weight) for each subject. Health history was self-reported by asking “Before your successful weight loss, had you been told by a physician that you had any of the following conditions” followed by a list of twenty health conditions. The list included hypertension, high cholesterol, diabetes, arthritis, thyroid disorder, sleep apnea, and major depression diagnosed by a professional.

Previous weight loss attempts and weight loss methods during successful attempt—Subjects were asked to report the number of times they had intentionally attempted to lose weight and the approximate weight loss during each effort. Subjects were asked to compare strategies used in prior weight loss efforts with their current successful weight loss. All subjects indicated whether they had lost weight through a formal program or on their own and indicated the types of resources used (commercial programs, self-help

groups, individual contact with psychologists, registered dietitians, personal exercise trainers, and physicians). They were also asked to report on other tools they used to successfully lose weight such as taking exercise classes, using prescription weight loss medications or diet pills, surgical procedures, diet programs from books or magazines or hypnotic techniques. Subjects were asked to respond to a series of questions about specific techniques used to limit or change dietary intake such as limiting certain foods, limiting fat intake, counting calories, or following a particular diet. A separate series of questions asked about techniques used to increase physical activity such as participating in exercise programs or exercising with family and friends, and the types of exercise used. Using 8-point Likert scales, subjects were asked to rate the importance and usefulness of various strategies used to lose or maintain weight, and the effort required to maintain body weight, follow exercise routines, and follow diet regimens.

Dietary intake and physical activity—Current dietary intake was assessed using the Block food-frequency questionnaire (10). Subjects were given a standardized list of 100 foods and asked to estimate their usual serving sizes and the frequency with which they consumed each food over the past year. Current physical activity was assessed using the Paffenbarger Physical Activity Questionnaire, a validated tool to assess weekly planned and lifestyle activity (11).

Psychological factors—Using a 5-point Likert scale, subjects were asked to rate the effect of successful weight maintenance on their general well-being, social interactions with others, and overall mood and psychological well-being. An 8-point Likert scale was used to assess satisfaction with current body weight. To assess depressive symptoms, the Center for Epidemiological Studies Depression Scale (CES-D) was used. The CES-D is a self-reported 20-item scale with higher scores indicating more depression (12). The 4-item version of the Perceived Stress Scale (PSS4) was used to assess the degree to which an individual appraises situations in his/her life as stressful with higher scores reflecting greater perceived stress (13).

Statistical methods

Classifications were made of all variables at three levels: nominal, continuous, and ordinal. Some variables were assigned new scales to simplify analysis (e.g., the number of alcoholic beverages per week was rescaled into a three category ordinal variable: 0 = 0, 1–5 = 2, 6+ = 3). Due to the skip pattern in many of the survey questions, variables with extensive missing data (each with more than 400 missing values) were excluded from the cluster analysis. All but 17 of the remaining variables had less than 1% of values missing and these 17 each had less than 4% of values missing. We imputed these missing values with the mean for continuous variables, the most frequent response for nominal variables, and the median response for ordinal variables.

To reduce the number of variables entered into the cluster analysis, a series of factor analyses were first performed on eight sets of ordinal (all were Likert scale) variables, in order to group-related questionnaire items into a smaller number of items. These eight sets of questionnaire items included the following: the degree to which the participant relied on

various weight loss strategies in achieving weight loss (7 items reduced to 6 items), the importance of common reasons for losing weight in motivating the successful weight loss effort (9 items reduced to 7 items), whether small or large changes would be used if weight re-gain occurred (6 items reduced to 4 items), the perceived effort currently required for activities of daily living such as paying bills and keeping the house clean (8 items reduced to 3 items), the perceived importance of the same activities of daily living (6 items reduced to 3 items), the pleasure derived from social interactions and other sources of entertainment such as reading a book, seeing beautiful scenery, having a lively talk, or spending time with friends (15 items reduced to 9 items), the impact weight loss has had on overall mood and psychological well-being (13 items reduced to 6 items), and the impact weight loss has had on health and general well-being (13 items reduced to 4 items). The resulting factored items were included in the cluster analysis, along with the remaining individual items from the NWCR baseline questionnaire.

All variables were inputted for cluster analysis via latent class cluster analysis using Latent Gold 3.0.6. Latent class cluster analysis uses a model-based approach which allows for mixed measurement levels (continuous, nominal, and ordinal variables), and allows for calculation of an individual's posterior class-membership probabilities based on the estimated model parameters and the individual's observed scores (14). Cluster analysis makes no distinction between dependent and independent variables and thus the entire set of interdependent relationships can be examined simultaneously. We thus included factors known before successful weight loss as well as factors relating to both weight loss and weight loss maintenance to examine the full "life-course" of an individual's weight status over time. We included demographic characteristics, health and weight history, behavioral strategies used for weight loss and weight loss maintenance, and factors such as depression, perceived stress, and effort and satisfaction with maintaining weight to better understand the array of attitudes, behaviors, and experiences of these individuals.

Analyses initially explored the fit of 4, 5, 6, and 7 cluster solutions. The different cluster solutions were assessed using the Bayesian information criteria and the L^2 statistic. The model with the lowest Bayesian information criteria is considered to have the best fit when considering both model fit and parsimony. A *P* value greater than 0.05 for the L^2 statistic also indicates adequate fit (i.e., a *P* value greater than 0.05 indicates failure to reject the null hypothesis of lack of fit). The posterior probability of membership in each of the clusters was calculated for the chosen 4-cluster solution and subjects were assigned to the most probable cluster. To aid in the interpretation and comparison of the clusters, cluster-specific means and frequencies for all variables of interest were recalculated after membership of the four clusters was determined. This allowed us to examine variables not included in the cluster analysis due to missing values, compare clusters using categorizations not used in the cluster analysis (e.g., calculating the proportion overweight rather than just reporting BMI), and report individual questionnaire items rather than reporting factor scores used for some items.

Results

The best fitting cluster solution revealed four unique clusters of NWCR participants. The 4-cluster solution had the lowest Bayesian information criteria and provided an overall adequate fit using the L^2 statistic ($P > 0.10$). Over 96% of participants ($n = 2,152$) had a posterior probability of two-thirds or greater for being a member of their assigned cluster, meaning they were more than twice as likely to be in their assigned cluster than in any other. The remaining 76 participants had posterior probabilities indicating potential membership in more than one cluster but were ultimately assigned to the cluster with the highest posterior probability. There were 69 participants sharing characteristics with both Cluster 1 and one of the other three clusters ($n = 57$ with Cluster 2; $n = 1$ with Cluster 3; $n = 11$ with Cluster 4), 2 participants sharing characteristics of both Clusters 2 and 3, 1 participant sharing characteristics of both Clusters 2 and 4, and 2 participants sharing characteristics of both Clusters 3 and 4. There were only two individuals with posterior probabilities of 0.1 or greater on more than two clusters, both sharing characteristics of Clusters 1, 2, and 4.

The four clusters differ in terms of demographic characteristics, weight and health history, reliance on weight-loss and weight-maintenance strategies, attitudes towards weight loss, and difficulty maintaining weight. Characteristics of the study participants at entry into the NWCR, by cluster assignment, are displayed in Table 1.

Cluster 1: “typical” NWCR participants (*N* = 1,125, 50.5% of participants)

The members of the first cluster can be described as “typical” NWCR participants and characterized as a weight-stable, healthy, exercise conscious group. Containing just over half (50.5%) of the sample, this cluster is most representative of NWCR members previously described in the literature. On average, this cluster had been maintaining a weight loss of at least 30 lbs below lifetime maximum weight (averaging 62.4 lbs below maximum) for an average of 5.8 years and the vast majority (77.2%) report being weight-stable during the year before enrollment (Table 2). At entry into the registry, this group had an average BMI of 23.4, reduced from a maximum lifetime BMI of 33.5. Before their successful weight loss, this cluster reports being relatively healthy, with the lowest percentage reporting a physician had diagnosed him or her with diabetes or sleep apnea before weight loss, and the second lowest percentage reporting a physician diagnosis of hypertension, high cholesterol, arthritis, thyroid disorder, or major depression (Figure 1).

All participants in this cluster reported previous unsuccessful weight loss attempts (Table 2). The majority (56.1%) report losing weight on their own without the help of any specific program or contact with a health care professional. The other members of this cluster used a variety of resources during their successful weight loss, including commercial programs (24.8%), physicians (10.9%), self-help groups (8.9%), and personal trainers (8.3%) (Figure 2).

Almost all (94.5%) report modifying their physical activity to accomplish their successful weight loss. Following an exercise routine is rated extremely important by this cluster of individuals for maintaining weight (Table 3). They report the highest weekly physical activity at entry into the registry (2,853 kcal/week). In addition to exercise, the most

commonly reported strategies for maintaining or losing weight during the year before registry entry include keeping many healthy foods in the house (96.6%), weighing on a regular basis (85.5%), and keeping few high-fat foods in the house (79.8%) (Figure 3). The members of Cluster 1 are the most satisfied with their current weight and report low levels of depression and stress as measured by the CES-D and PSS4, respectively (Table 3).

Cluster 2: "struggling" NWCR participants (*N* = 599, 26.9% of participants)

The members of the second cluster struggle the most with their weights, are more likely to weight cycle, require more effort to lose and maintain weight, and have poorer overall health compared to other NWCR members. This group has the highest maximum lifetime BMI (44.7) as well as the highest BMI (28.6) at entry into the registry (Table 2). This cluster is also trying to maintain the greatest weight loss, an average of 100.5 lbs below maximum weight. In addition, this cluster contains the highest percentage of members currently trying to lose weight (84.1%) and the highest percentage reporting weight-cycling in the past year (25.6%). The members of this cluster are much more likely to have been overweight during childhood and adolescence compared to other clusters, and more likely to have overweight family members (Table 1).

This is the youngest cluster with an average age of 45.7 years, and contains the highest proportion of females (83.1%), although these demographics are similar to those for Cluster 1. Despite being the youngest cluster, this cluster was the least healthy of the four clusters before successful weight loss, with the highest self-reported prevalence of hypertension, high cholesterol, diabetes, sleep apnea, and major depression, and similar rates of arthritis and thyroid problems as Cluster 4 (Figure 1).

The members of this cluster are the least likely to report losing weight on their own (38.0%) and they utilize all professional resources more than the other clusters, such as commercial weight loss programs (30.6%), physicians (21.8%), and self-help groups (19.4%) (Figure 2). This group was also most likely to report using prescription weight loss medications and diet pills, surgical procedures, diet programs from books or magazines, and hypnosis for their successful weight loss (Table 2). They were also the most likely to report using physical activity to achieve weight loss. Compared to other clusters, this group consistently rated specific dietary strategies (e.g., limiting all foods or types of food, counting calories, counting fat grams, using an exchange diet or a low-fat/low-calorie diet) as more important to their successful weight loss (data not shown), a further indication that this cluster relied on a multitude of strategies to lose weight.

With respect to current strategies for maintaining weight (or losing additional weight) during the past year, this cluster again reports using each of the strategies (keep few high-fat foods in house, keep many healthy foods in house, decrease restaurant meals, regular weighing, food and exercise records) more often than other clusters (Figure 3) and were most likely to have participated in a commercial weight loss program during the year before enrollment (Table 2). Although they rate the importance of following an exercise routine almost as highly as Cluster 1, their estimated amount of physical activity is lower (2,492 vs. 2,854 kcal/ week) (Table 3) and they consume slightly more calories per day (1,457 kcal). Overall, they appear to constantly struggle to keep weight down and control their eating behavior and

report more difficulty maintaining weight loss than any other cluster, and report having more difficulty maintaining weight loss during vacations, illness, when under stress, or during change of season. Compared to the other clusters, this cluster is least satisfied with their weight loss, are most depressed, and least able to cope with stress (Table 3).

Cluster 3: NWCR participants with "immediate and long-term success" (*N* = 283, 12.7% of sample)

The distinguishing characteristic of the third cluster is that 94.8% of the individuals in this cluster had no previous weightloss attempts before their successful attempt (Table 2). At entry into the registry, this group had an average BMI of 23.3 (similar to the "typical" cluster; much lower than the other two clusters), but also had the lowest maximum lifetime BMI of 32.0. This group is trying to maintain the smallest amount of weight loss, an average of 56 lbs below maximum lifetime weight, and have maintained a weight loss of at least 30 lbs below maximum for an average of 11.1 years, almost 5 years longer than any other cluster. This is the most weight-stable group (79.0%), with the lowest percentage currently trying to lose weight (35.2%). The members of this cluster were least likely to have been overweight as children or adolescents, and least likely to have a family history of overweight. This group has the highest proportion of males (41.6%) and is the second oldest cluster with an average age of 51.2 years. The individuals belonging to this cluster have the highest education (60.2% have a college degree) and are most likely to be married (68.6%), although both proportions are only slightly higher than those in the "typical" cluster (Table 1).

This group can be described as the healthiest group (Figure 1) despite being the second oldest cluster. This group of individuals was by far the most likely to report losing weight on their own (72.3%) and least likely to consult with a psychologist, counselor, or dietitian on weight issues (Figure 2). Furthermore, they are less likely to join commercial weight loss programs or use self-help groups. They were also the least likely to take prescription weight loss medications or diet pills during successful weight loss (Table 2). Compared to Clusters 1 and 2, this group is also less likely to report using other tools and strategies during their successful weight loss or for maintaining or losing additional weight during the past year, except for weighing self-regularly, which was used by ~85% of individuals in each cluster (Figure 3).

This group has the least difficulty maintaining current weight, report less effort following their exercise routine, and report little conflict between eating vs. maintaining weight (Table 3). Similar to Cluster 1, the members of this cluster are satisfied with their current weight, and have low levels of depression and stress.

Cluster 4: "less physically active" NWCR participants (*N* = 221, 9.9% of participants)

The primary factor that differentiates this cluster from the other three clusters is the low levels of physical activity reported. This group is the oldest group with a mean age of 53.3 years with a lower proportion of females (71.7%) than Clusters 1 and 2 (Table 1). This group is less educated and more likely to be divorced (21.9%) compared to the other clusters. The average BMI at registry entry (26.1) and maximum lifetime BMI (37.3) are

both higher than the typical NWCR participant, but lower than observed in Cluster 2 (Table 2). They report a similar history of personal and parental overweight as Cluster 1. Except for Cluster 2, this group is the least healthy with more thyroid and arthritis problems (Figure 1).

Almost all (93.8%) tried losing weight before unsuccessfully. Although less likely to use a commercial program during their successful weight loss compared to typical members (Figure 2), this group was more likely to utilize self-help groups, and more likely to consult with physicians, psychologists or counselors. Only 45.8% report modifying physical activity for weight loss and the importance of currently following an exercise routine was rated extremely low by this cluster of individuals (3.2 vs. 7.5 in the typical cluster). It was estimated that this cluster only expended 728 kcal/week in physical activity, which was also far below the other clusters (Table 3). This group reports eating fewer meals per day than the other clusters, but consume a higher proportion of calories from fat and lower proportion of calories from carbohydrates.

Discussion

This is the first study to use cluster analysis to identify subgroups of individuals successful at weight loss maintenance, suggesting that weight loss maintenance may not be a “one size fits all” strategy. Sustaining weight loss after obesity treatment remains a challenge. It is generally accepted that individual differences in response to weight loss strategies exist and are important to understand in order to improve success. However, few studies have had sufficient sample size to evaluate potential individual differences in weight loss maintenance. The NWCR, with a large number of participants, provides the opportunity to examine individual differences. Using subjects in the NWCR, we were able to identify four distinct groups of successful weight loss maintainers.

Most of the NWCR participants fell into a cluster (Cluster 1) that fits well with most of the previously published characteristics of successful weight loss maintainers, including publications from the NWCR. However, there were some smaller clusters of individuals who appear to differ in how they are maintaining their weight loss. Of particular interest, individuals in Cluster 2 were more likely to have been obese as children, had lost more weight, used more structured help for weight loss and appeared to struggle harder to maintain their weight loss.

Cluster 3 seems to be individuals who succeed on their first try at weight loss. This cluster has the highest percentage of men. One of the criticisms leveled at the NWCR has been that it only consists of people for whom weight loss and weight loss maintenance is easy. This cluster appears to exemplify those individuals, but only represents about 13% of total NWCR participants. About a quarter of NWCR participants (Cluster 2) actually struggle with weight loss and weight loss maintenance and rely on more strategies and support to achieve and maintain weight loss. The last cluster (Cluster 4) consists of individuals who are successful at weight loss maintenance but do not appear to be engaging in as many of the lifestyle behaviors as members of the other clusters. There is some evidence that this group may be controlling their weight by eating less, perhaps by feeling less hunger or having a lower desire to eat. They report the lowest average caloric intake and consume fewer meals

per day, yet they are most likely to report that they can eat what they want and still maintain their weight.

Since a large number of variables were included in the cluster analysis, a local independence model was assumed. The drawback to this assumption is that highly correlated items on the questionnaire (e.g., multiple questions on weight history) are weighted more heavily in the classification formula than less correlated items. As a result, the analysis did differentiate clusters based on domains frequently assessed in the questionnaire (e.g., physical activity; weight history; comparisons to previous weight loss attempts). Although it may not be surprising that those who lost weight on their first attempt defined a cluster, what is more interesting is the other characteristics of this cluster, such that this group was predominantly male, less likely to be overweight as children, had the longest weight loss maintenance, and report the least difficulty and effort in maintaining weight. Similarly, Cluster 4, which formed a cluster primarily because these individuals rarely used physical activity as a weight loss strategy, did not report using many other strategies to compensate, other than consuming fewer meals per day than members of the other clusters.

These results are important because it is now clear that it is possible for different people to use different strategies for successful weight loss maintenance, although some may also struggle substantially more than others in doing so. For example, while most successful weight-reduced individuals seem to require very high amounts of physical activity to maintain their weight, some do not. The identification of distinct subgroups of reduced-obese individuals is a first step in better understanding how to provide tailored strategies to help with weight loss maintenance. Future investigation will determine whether it may be possible to prospectively identify which cluster an obese individual may fall into to help tailor support and interventions.

In summary, not all reduced-obese individuals are the same and it will likely be necessary to develop different weight loss maintenance strategies, requiring different levels of resources and support, tailored to the specific characteristics of an individual.

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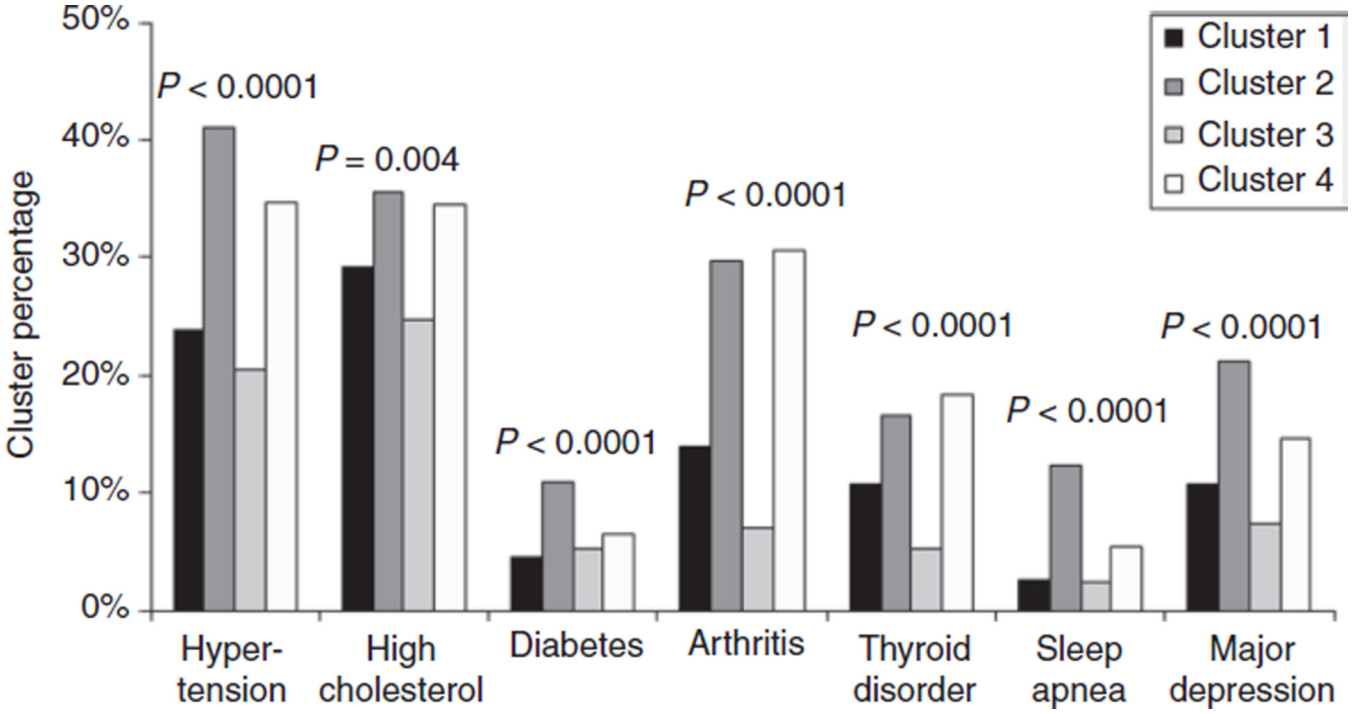

Figure 1.

Health history before successful weight loss. Questionnaire item: prior to your successful weight loss, had you been told by a physician that you had any of the following conditions?

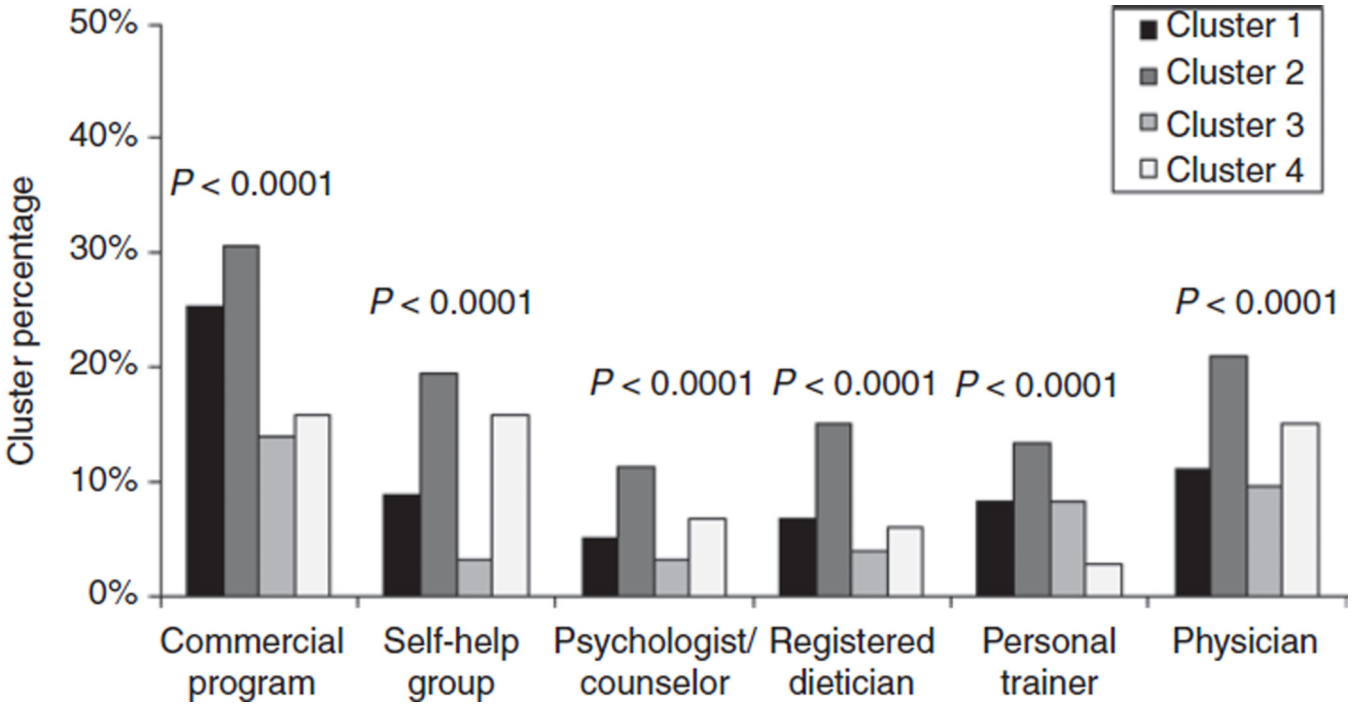

Figure 2.

Professional and group resources utilized during successful weight loss. Questionnaire item: in achieving this most recent successful weight loss, you may have used several different approaches. Please indicate which of the following strategies you used to lose weight.

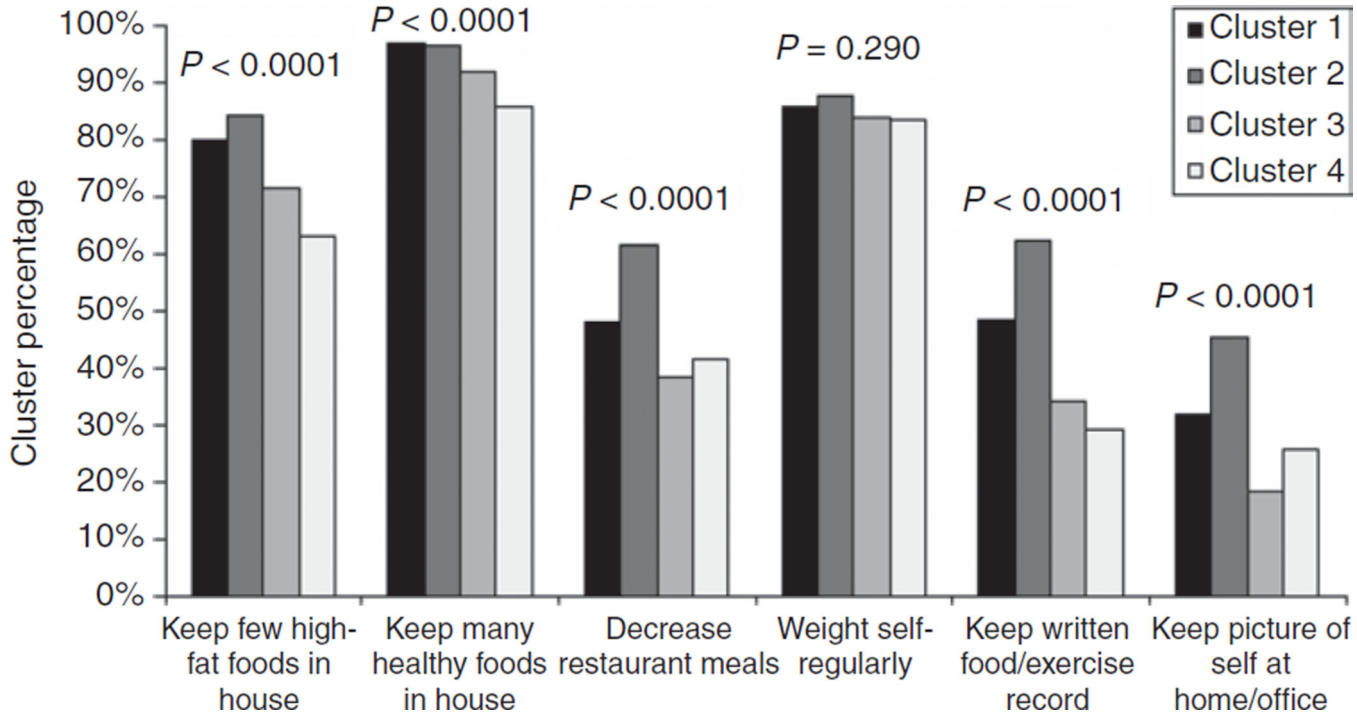

Figure 3.

Current self-regulation and self-monitoring strategies used to maintain or lose weight. Questionnaire item: please indicate for each item whether or not you have used this strategy to maintain or lose weight during the past year.

Table 1

Characteristics of NWCR participants at registry entry, by cluster assignment

Variable	Cluster 1, *N* = 1,125	Cluster 2, *N* = 599	Cluster 3, *N* = 283	Cluster 4, *N* = 221	*P* value
Age (years)	46.4	45.7	51.2	53.3	<0.0001
Gender (% female)	81.2	83.1	58.4	71.7	<0.0001
Education (%)					
Junior high	0.4	0.7	0.4	0.8	
High school	9.4	13.7	8.3	14.8	
Vocational	6.3	8.0	5.9	8.3	
Some college	26.0	28.1	25.3	28.4	
College	26.6	24.7	27.0	24.2	
Graduate/professional	31.2	24.9	33.2	23.6	<0.0001
Marital status (%)					
Married	68.0	53.9	68.6	59.8	
Separated	1.7	3.9	1.1	0.5	
Divorced	11.4	16.3	10.0	21.9	
Widowed	3.0	04.2	6.4	6.1	
Never married	12.1	18.0	11.9	8.6	
Not married	2.9	2.9	0.7	0.9	
Other	1.0	0.8	0.4	2.3	<0.0001
Race/ethnicity (%)					
Non-Hispanic white	95.4	93.0	93.3	96.4	
African American	1.8	3.9	2.8	2.3	
Asian	0.6	0.0	0.4	0.0	
Hispanic	1.3	1.9	1.1	0.2	
Other	0.8	1.1	2.5	0.9	0.31
History of overweight (%)					
Preschool	16.4	32.2	9.4	19.2	<0.0001
Elementary school	40.3	62.0	25.2	37.0	<0.0001
Junior high	49.4	76.0	30.9	50.7	<0.0001
High school	50.3	74.8	30.5	46.1	<0.0001

Variable	Cluster 1, *N* = 1,125	Cluster 2, *N* = 599	Cluster 3, *N* = 283	Cluster 4, *N* = 221	*P* value
Overweight mother (%)	55.7	65.2	49.3	57.9	<0.0001
Overweight father (%)	45.9	52.6	36.3	44.9	<0.0001
Current smoker (%)	7.9	12.9	8.5	12.0	0.012

NWCR, National Weight Control Registry.

Obesity (Silver Spring). Author manuscript; available in PMC 2015 September 08.

Table 2

Weight history, current weight, and current weight goals of NWCR participants, by cluster assignment

	Cluster 1, *N* = 1,125	**Cluster 2, *N* = 599**	**Cluster 3, *N* = 283**	**Cluster 4, *N* = 221**	***P* value**
Current BMI (kg/m^2)	23.4	28.6	23.3	26.1	<0.0001
BMI category (%)					
Normal weight, <25.0kg/m^2	76.3	27.2	78.7	50.9	
Overweight, 25.0–29.9 kg/m^2	20.5	41.9	18.8	32.3	
Obese, ≥30.0kg/m2	3.2	30.9	2.5	16.8	<0.0001
Maximum BMI (kg/m^2)	33.5	44.7	32.0	37.3	<0.0001
Maximum-current weight (lbs)	62.4	100.5	56.0	70.4	<0.0001
Duration of weight maintenance (months)[a]	69.7	55.8	133.5	75.7	<0.0001
Tried to lose weight previously (%)	100.0	98.3	5.2	93.8	<0.0001
Lost weight on own (%)[b]	56.1	38.0	73.2	43.1	<0.0001
Weight loss methods[c]					
Exercise classes	30.1	37.7	21.7	6.5	<0.0001
Book/magazine diet	21.6	24.1	17.9	23.0	0.23
Prescription or diet pills	7.3	17.8	3.2	8.2	<0.0001
Surgical procedure	1.2	9.7	0.0	5.2	<0.0001
Hypnosis	1.2	1.9	0.0	0.9	0.58
Weight pattern during past year (%)					
Gained weight	3.5	12.0	4.6	5.5	
Lost weight	15.2	25.5	14.1	22.0	
Stable ± 5 lb	77.2	38.9	79.0	63.4	
Gained and lost weight	4.1	23.6	2.3	9.1	<0.0001
Current weight goal (%)					
Maintain weight	54.9	15.6	64.4	48.4	
Lose weight	44.4	84.1	35.2	51.6	
Gain weight	0.7	0.3	0.4	0.00	<0.0001
Current weight loss/maintenance methods[d]					
Commercial program	30.0	45.0	17.0	34.5	<0.0001
Diet/exercise books/magazines	75.5	79.0	61.2	53.4	<0.0001

	Cluster 1, *N* = 1,125	Cluster 2, *N* = 599	Cluster 3, *N* = 283	Cluster 4, *N* = 221	*P* value
Prescription diet drugs	0.7	2.1	0.4	0.5	0.06

BMI, body mass index; NWCR, National Weight Control Registry.

[a] Duration of time since participant lost at least 30 lbs from maximum (months).

[b] Lost weight on own without specific program or health professional (%).

[c] In achieving this most recent successful weight loss, you may have used several different approaches. Please indicate which of the following strategies you used to lose weight (select all that apply).

[d] Please indicate whether or not you have used this strategy to maintain or lose weight during the past year (select all that apply).

Table 3

Behavioral and psychological characteristics of NWCR participants, by cluster assignment

	Cluster 1, *N* = 1,125	Cluster 2, *N* = 599	Cluster 3, *N* = 283	Cluster 4, *N* = 221	*P* value
Current physical activity (kcal/week)	2,853.6	2,492.1	2,660.7	727.8	<0.0001
Current energy intake (kcal/week)	1,372.6	1,457.1	1,419.4	1,351.9	0.071
Macronutrient composition of diet (percent of total calories)					
Carbohydrates	54	53	53	48	
Fat	26	28	27	31	
Protein	18	19	18	19	<0.0001
Difficulty in maintaining current weight (1 = extremely easy to 7 = extremely hard)	3.5	4.7	3.3	3.4	<0.0001
Experiences food cravings (%)	80.7	90.6	66.0	73.5	<0.0001
How many times do you eat/day?	4.7	4.9	4.3	4.2	<0.0001
How many days/week do you eat breakfast?	6.4	6.3	6.3	5.7	<0.0001
Constant conflict between eating vs. maintaining weight (%)	30.4	71.9	23.5	27.1	<0.0001
Can eat what I want and maintain weight (%)	27.7	6.8	36.8	37.5	<0.0001
Importance of following exercise routine (1 = not important at all to 8 = extremely important)	7.5	7.4	7.3	3.2	<0.0001
Effort in following exercise routine (1 = no effort at all to 8 = extreme effort)	3.1	4.8	2.8	4.5	<0.0001
Satisfaction with current weight (1 = very unsatisfied to 8 = very satisfied)	6.7	4.9	6.7	6.1	<0.0001
Depression inventory	7.9	14.3	7.5	10.2	<0.0001
Cohen stress scale	4.4	6.5	4.1	4.9	<0.0001

NWCR, National Weight Control Registry.