Are the Eating and Exercise Habits of Successful Weight Losers Changing?

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Abstract

Objective: The purpose of this study was to examine whether the diet and exercise behaviors of successful weight losers entering the National Weight Control Registry (NWCR) have changed between 1995 and 2003.

Research Method and Procedures: Participants (N = 2708) were members of the NWCR who enrolled in intermittent years since 1995. Participants had lost an average of 33.1 kg and maintained a 13.6-kg loss for 5.8 years before enrollment. Evaluations of diet and physical activity were conducted at entry into the NWCR and prospectively over 1 year.

Results: From 1995 to 2003, the daily percentage of calories from fat increased from 23.8% to 29.4%, saturated fat intake increased from 12.3 to 154.0 g/d, and calories from carbohydrate decreased from 56.0% to 49.3% (p < 0.0001). The proportion consuming <90 grams of carbohydrate (considered a low-carbohydrate diet) increased from 5.9% to 17.1% (p = 0.0001). Physical activity was elevated in 1995 (mean = 3316 kcal/wk) but comparable in all other years (mean = 2620 kcal/wk). Stepwise regression collapsing across cohorts indicated that weight regain over 1 year was related to higher levels of caloric intake, fast food consumption, and fat intake and lower levels of physical activity (p < 0.03).

Discussion: The macronutrient composition of the diet of NWCR members has shifted over the past decade. Still,

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only a minority consumes a low-carbohydrate diet. Despite changes in the diet over time, the variables associated with long-term maintenance of weight loss were the same: continued consumption of a low-calorie diet with moderate fat intake, limited fast food, and high levels of physical activity.

Key words: weight loss, weight maintenance, diet, physical activity, National Weight Control Registry

Introduction

Nearly 10 years ago, we reported initial descriptive analyses of 784 successful weight losers who had enrolled in the National Weight Control Registry (NWCR)¹ between 1994 and 1997 (1). The NWCR is a registry of participants who have lost \geq 13.6 kg (30 lb) and maintained the loss for \geq 1 year. The initial 784 participants far exceeded these minimum criteria: participants lost an average of 30 kg and maintained the minimum 13.6 kg loss for an average of 5.5 years. Other characteristics included eating a low-calorie (1360 kcal/d) diet, eating a low-fat (24% calories from fat) diet, engaging in a high level of physical activity (~2786 kcal/wk), frequent self-weighing, and eating regular meals, including breakfast (1,2).

Given the fact that the Registry is now nearly 10 years old, we were interested in re-examining the weight loss and maintenance behaviors of individuals entering the NWCR to examine whether the characteristics of successful weight losers have changed between 1995 and 2003. Specifically, this study examined changes in the weight maintenance behaviors of Registry members enrolled in intermittent years since 1995 (i.e., in 1995, 1997, 1999, 2001, and 2003). Furthermore, we examined the relationship between the characteristics of successful weight losers and subsequent 1-year weight changes.

Research Methods and Procedures

Subjects

Participants were 2123 women and 585 men who enrolled in the Registry in 1995, 1997, 1999, 2001, and 2003. To be eligible for enrollment, individuals must have lost \geq 13.6 kg (30 lb), maintained the weight loss for \geq 1 year, and be ≥ 18 years. Of the 2708 participants enrolled in the Registry in 1995, 1997, 1999, 2001, and 2003, 2266 (83.7%) completed the 1-year assessment. Independent Student's t tests comparing participants who withdrew vs. those who completed the 1-year assessment revealed significant differences in baseline age, BMI, body weight, and magnitude below maximum lifetime weight. At baseline, individuals who subsequently dropped out were younger (43.6 \pm 12.8 vs. 47.5 \pm 12.6 years; p = 0.0001) weighed more $(73.8 \pm 17.6 \text{ vs. } 71.1 \pm 15.7 \text{ kg}; p = 0.001)$, had a higher BMI (25.7 \pm 5.2 vs. 25.0 \pm 4.7 kg/m²; p = 0.005), and had lost more weight at entry into the Registry (35.6 \pm 19.0 vs. 32.6 \pm 17.6 kg; p = 0.001). χ^2 analyses revealed no significant differences in dropout as a function of race or sex.

Procedures

Prospective participants were recruited through coverage of the NWCR provided by local and national media sources describing the Registry and its entry criteria. Interested participants were asked to call a 1-800 number or visit the study web site to receive NWCR enrollment information. Consent form and questionnaire packets were mailed to these individuals. Participants provided information on their lifetime maximum weight, current weight, and approximate date at which they were at these weights. This information was used to determine whether they met the eligibility criterion of maintaining a weight loss of 30 lb (13.6 kg) or more for at least 1 year. All participants volunteered to participate in the Registry and were not compensated for participation in the study. This study was approved by the Miriam Hospital Institutional Review Board for the Protection of Human Subjects in Research, Providence, RI.

Measures

Demographic. All subjects completed a questionnaire requesting standard demographic information (age, ethnicity, education level, and martial status) and details about weight history (maximum lifetime weight, current weight, duration of the required minimum 13.6 kg weight loss). Weight information was used to calculate BMI (kilograms per meters squared). The reliability and validity of Registry participants' self-reported weight information have been documented previously (3).

Weight Maintenance Methods. Participants were asked about what they were currently doing to maintain their weight loss. Dietary intake was assessed by using a scannable version of the Block Food-Frequency Questionnaire (4), which yields estimates of daily energy intake, percentage of calories from fat, carbohydrate, and protein, daily intake of saturated fat, daily intake of fiber (in grams), and daily servings from various food groups (i.e., meat/poultry/ fish/beans/eggs, fats/oils/sweets, milk/yogurt/cheese, bread/ cereal/rice/pasta, fruit/fruit juice, and vegetables). Frequency of breakfast consumption, number of daily meals, and frequency of fast food consumption were also evaluated. To assess current levels of physical activity, participants completed the Paffenbarger physical activity questionnaire (5), which asks for information about walking, stair climbing, and recreational activities engaged in during the past week.

Follow-up Assessment. One year after their initial entry into the Registry, participants were asked to again report their present weight and to complete assessments pertaining to their weight maintenance methods (i.e., the Block questionnaire and Paffenbarger, as described above).

Statistics

Data are expressed as means \pm standard deviation. Analyses were conducted using weight change (kg) data, calculated as weight at year 1 minus weight at study entry. Differences among cohorts were evaluated using ANOVA trends test and analysis of covariance trends tests, which adjusted for significant group differences in demographic factors. Differences in the frequencies for categorical variables were analyzed using the Wald χ^2 test. Pearson product-moment correlation coefficients were calculated to determine the extent of linear associations among the principal variables of the study. We examined the relationship between behavioral characteristics and subsequent weight change using multiple regression and stepwise regression analyses, controlling for potential confounders. In the analysis of nutrient data, both the percentage of calories from various macronutrients and grams of macronutrients were examined. In the regression analyses, findings are based on the percentages of calories from macronutrients; however, analyses conducted using grams of macronutrients per 1000 calories yielded the same statistical conclusions.

Results

Characteristics of Subjects

Across years, enrollees differed significantly on demographic factors. Compared with early enrollees (year = 1995), later enrollees (year = 2003) were more likely to be male (26.7% vs. 19.2%), had a higher maximum lifetime weight (110.4 vs. 101.6 kg), had higher weight at study entry (74.2 vs. 71.3 kg), and had lost more weight before entering the Registry (36.2 vs. 30.3 kg). Subsequent analyses adjusted for these and the other modest, but statistically significant, demographic differences (Table 1).

	All						
	participants $(N = 2708)$	1995 (<i>N</i> = 396)	1997 (<i>N</i> = 949)	1999 (<i>N</i> = 733)	2001 (<i>N</i> = 287)	2003 (<i>N</i> = 343)	р
Age (years)	46.9 ± 12.6	45.2 ± 11.5	45.5 ± 12.6	48.3 ± 13.2	50.3 ± 12.5	46.8 ± 11.7	0.087
Weight (kg)	71.5 ± 16.1	71.3 ± 14.8	69.9 ± 15.7	71.5 ± 15.0	74.1 ± 17.4	74.1 ± 18.9	0.017
BMI (kg/m^2)	25.1 ± 4.8	25.1 ± 4.1	24.6 ± 4.7	25.0 ± 4.5	26.2 ± 5.6	25.6 ± 5.6	0.145
Maximum weight	104.6 ± 27.4	101.6 ± 24.9	103.0 ± 26.7	104.7 ± 27.6	107.1 ± 28.1	110.4 ± 29.7	<.001
BMI at maximum weight	36.7 ± 8.8	35.8 ± 7.5	36.3 ± 8.7	36.6 ± 8.9	38.0 ± 9.8	38.2 ± 9.3	0.000
Weight loss (kg)	33.1 ± 17.9	30.3 ± 16.0	33.1 ± 18.1	33.1 ± 18.4	33.0 ± 17.6	36.2 ± 18.3	<.001
Weight maintenance							
duration (months)	70.1 ± 90.1	58.0 ± 68.1	77.4 ± 96.1	71.1 ± 92.1	73.1 ± 102.2	59.5 ± 78.0	0.819
Sex (% female)	78.4%	80.8%	81.4%	76.1%	76.8%	73.3%	0.006
Education (%)							
High school or less	11.6%	11.9%	12.8%	10.9%	15.4%	6.5%	0.006
Some college	33.7%	35.1%	37.0%	33.3%	35.8%	22.3%	0.000
College or university	25.6%	25.3%	24.6%	27.0%	18.6%	31.7%	0.004
Graduate degree	29.0%	27.8%	25.6%	28.8%	30.2%	39.6%	0.001
Marital status							
Married	63.8%	67.9%	63.4%	62.1%	66.2%	61.5%	0.244
Separated or divorced	14.5%	10.6%	15.1%	16.1%	14.6%	14.1%	0.156
Single	21.7%	21.5%	21.5%	21.8%	19.2%	24.4%	0.627
Ethnic status							
White	95.4%	96.7%	95.1%	95.1%	95.8%	95.3%	0.735
African-American	2.1%	1.5%	2.2%	2.3%	2.1%	2.1%	0.925
Asian	0.4%	0.0%	0.4%	0.3%	0.7%	0.6%	0.557
Hispanic	1.1%	1.5%	1.2%	1.2%	0.7%	0.9%	0.871
Other	0.9%	0.3%	1.1%	1.1%	0.7%	1.2%	0.600

Table 1. Demographic characteristics of successful weight losers by year of study entry

Weight Maintenance Methods

Significant differences in total daily calorie intake was observed across cohorts (F = 2.7; p = 0.04), but this was caused by an unusually low reported intake in 2003 (Table 2). Differences in dietary composition were also evident. Specifically, a significantly higher level of fat intake was observed in later enrollees (F = 74.7, p = 0.0001); the earliest cohort consumed an average of $23.8 \pm 7.8\%$ calories from fat, whereas the most recent cohort consumed $29.4 \pm 11.7\%$ calories from fat per day. A similar pattern was observed in daily intake of saturated fat (Table 2). Saturated fat intake increased from 12.3 ± 7.3 g/d in 1995 to 15.0 ± 11.5 g/d in 2003 (F = 17.1, p = 0.0001). In contrast to the observed increase in fat and saturated fat consumption, the percentage of calories from carbohydrate decreased across cohorts (F = 76.6, p = 0.0001; Table 2), from 56.0 \pm 8.9% in 1995 to 49.3 \pm 13.8% in 2003. Dietary fiber from beans and vegetables/fruit increased, whereas fiber from grains decreased significantly across cohorts (Table 2). Protein consumption remained relatively stable (Table 2).

Changes in daily servings from various food groups (i.e., fats, vegetables, breads, and meat) paralleled the changes in fat, carbohydrate, and protein reported above. Specifically, daily servings from fat/oil/sweets increased across the years (Table 3). Servings of bread/cereal/rice/pasta decreased, while daily vegetable servings increased significantly (Table 3). Servings per day of meat/poultry increased, whereas daily servings of milk/yogurt/cheese decreased across years (Table 3). No statistically significant differences in frequency of breakfast consumption (mean = 6.3 ± 1.8 d/wk), fast food consumption (mean = 0.77 ± 1.5 meals/wk), or meal frequency (mean = 4.7 ± 1.7 times/d) were observed.

We also examined the proportion of participants consuming a low-fat (<20% kcal from fat), recommended level of fat intake (20% to 35% kcal from fat), or high-fat (>35%

	All						
	participants	1995	1997	1999	2001	2003	Adjusted
	(N = 2708)	(N = 396)	(N = 949)	(N = 733)	(N = 287)	(N = 343)	<i>p</i> *
Calorie intake (kcal/d)	1379 ± 573	1399 ± 534	1371 ± 564	1407 ± 575	1383 ± 660	1322 ± 555	0.04
Fat intake							
Percent kcals fat/d	26.6 ± 10.0	23.8 ± 7.8	25.5 ± 8.8	26.4 ± 9.6	30.4 ± 12.3	29.4 ± 11.7	< 0.0001
Fat (g/d)	$41.9 \pm .7$	37.1 ± 20.0	40.0 ± 24.3	42.9 ± 28.5	48.8 ± 36.9	45.0 ± 31.5	>0.0001
Saturated fat (g/d)	14.0 ± 10.2	12.3 ± 7.3	13.2 ± 8.9	14.5 ± 10.4	16.6 ± 14.0	15.0 ± 11.5	>0.0001
Carbohydrate intake							
Percent kcals							
carbohydrate/d	53.4 ± 11.3	56.0 ± 8.9	54.8 ± 9.8	53.6 ± 11.0	49.9 ± 13.9	49.3 ± 13.8	>0.0001
Carbohydrates (g/d)	181.9 ± 81.4	196.3 ± 82.5	186.1 ± 81.0	185.1 ± 78.3	168.4 ± 86.5	159.9 ± 77.0	>0.0001
Fiber (g/d)	16.6 ± 8.6	17.1 ± 8.7	15.8 ± 8.1	17.4 ± 8.3	16.4 ± 9.7	17.1 ± 9.1	0.003
Fiber beans (g/d)	2.4 ± 2.9	2.4 ± 3.3	2.2 ± 2.6	2.6 ± 2.7	2.5 ± 3.5	2.7 ± 3.3	0.02
Fiber grains (g/d)	4.8 ± 3.3	5.5 ± 3.6	4.8 ± 3.2	4.9 ± 3.3	4.3 ± 3.3	4.1 ± 2.9	0.001
Fiber veg/fruit (g/d)	9.4 ± .2	9.2 ± 4.8	8.8 ± 4.9	9.8 ± 4.9	9.5 ± 5.9	10.4 ± 6.1	0.01
Protein intake							
Percent kcals protein/d	18.6 ± 4.2	19.1 ± 3.9	18.4 ± 4.0	18.5 ± 4.4	18.5 ± 4.6	19.3 ± 4.7	0.37
Protein (g/d)	63.5 ± 29.2	65.7 ± 26.2	62.3 ± 29.2	64.2 ± 28.1	63.2 ± 34.6	63.3 ± 29.6	0.42
Physical activity (kcal/wk)	2691 ± 2494	3379 ± 3323	2593 ± 2317	2581 ± 2481	2310 ± 2169	2735 ± 1932	0.0003

Table 2. Dietary and exercise behaviors of successful weight losers by year of study entry

* p value is adjusted for age, weight, weight loss, highest lifetime weight, gender, education, and marital status.

kcal from fat) diet, as defined by the United States Department of Agriculture (6). The proportion consuming a highfat diet increased over time (from 7.5% to 21.6%), whereas the proportion consuming a low-fat diet decreased (from 35.5% to 21.0%). The proportion consuming a diet within the recommended ranges of fat intake (i.e., 20% to 35% kcal from fat) remained stable over time, and this level of fat intake was consumed by the majority of participants in each year (Figure 1). We also evaluated the proportion of participants consuming a low-carbohydrate diet, defined as a diet containing <90 grams of carbohydrate. This level was chosen because 90 grams of carbohydrate is the most carbohydrate allowed by popular low-carbohydrate diets. Across cohorts, significant differences were observed ($\chi^2 = 41.1$, p = 0.0001), with a greater proportion of participants consuming a lowcarbohydrate diet in later years (Figure 2). Although the proportion of Registry participants consuming a low-carbo-

Table 3.	Servings per da	y of various food	groups among	successful weight 1	losers by year of study ent	try
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	All participants $(N = 2708)$	1995 (<i>N</i> = 396)	1997 (<i>N</i> = 949)	1999 (<i>N</i> = 733)	2001 (<i>N</i> = 287)	2003 (<i>N</i> = 343)	Adjusted p*
Bread, cereal, rice, pasta	2.2 ± 1.2	2.4 ± 1.2	2.4 ± 1.2	2.2 ± 1.2	1.9 ± 1.2	1.8 ± 1.0	0.001
Fat, oils, sweets	1.6 ± 1.6	1.3 ± 1.4	1.7 ± 1.6	1.7 ± 1.6	1.9 ± 1.7	1.6 ± 1.4	0.0001
Fruit/fruit juice	2.1 ± 1.2	1.9 ± 1.4	2.1 ± 1.2	2.2 ± 1.2	2.0 ± 1.3	2.0 ± 1.3	0.004
Vegetables	3.3 ± 1.7	3.2 ± 1.7	3.2 ± 1.7	3.3 ± 1.7	3.4 ± 1.8	3.7 ± 1.9	0.01
Meat, poultry, fish, beans, eggs	1.4 ± 1.0	1.2 ± 0.7	1.3 ± 0.7	1.4 ± 0.9	1.6 ± 1.2	1.7 ± 1.4	0.0001
Milk, yogurt, cheese	2.2 ± 1.7	2.4 ± 1.9	2.3 ± 1.8	2.2 ± 1.6	2.2 ± 1.9	1.9 ± 1.5	0.005

* p value is adjusted for age, weight, weight loss, highest lifetime weight, gender, education, and marital status.



Figure 1: Proportion of participants consuming a low (<20% kcal), recommended (20% to 35% kcal), or high (>35% kcal) fat diet among five NWCR cohorts.

hydrate diet increased almost 3-fold over time, <17% of participants in later years followed such a diet.

Although statistically significant differences in physical activity were observed (F = 5.2, p = 0.02), this effect was caused by an unusually high level of physical activity reported in 1995 (Table 2). In subsequent years, physical activity remained high and was >2300 kcal/wk in each cohort. A similar pattern was observed with amount of walking and stair climbing as well as calories expended in light, medium, and heavy physical activity.

One-year Follow-up

Similar to findings in previous reports (3,7,8), subjects regained 2.1 \pm 5.3 kg over the course of 1 year of follow-up.

Despite differences in macronutrient composition across cohorts (reported above), no significant differences in magnitude of weight regain were found across years after con-



Figure 2: Proportion of participants consuming <90 grams of carbohydrate.

trolling for significant demographic covariates. Moreover, within each cohort, the variables associated with 1-year weight regain were the same. Thus, analyses collapsing across cohorts were conducted and are reported here. Oneyear weight regain was associated with higher age (r =0.075, p = 0.0001, lower body weight (r = -0.057, p =0.0001), greater weight loss (r = -0.085, p = 0.0001), and shorter duration of successful weight loss maintenance (r =0.167, p = 0.0001) at entry into the study. Weight regain was also significantly related to dietary variables measured at entry into the study, including higher total energy intake (r = -0.05, p = 0.05), higher percentage of calories from protein (r = -0.06, p = 0.01), greater fast food consumption (r = 0.10, p = 0.0001), and less frequent breakfast consumption (r = -0.05, p = 0.01). Examining 1-year changes in macronutrient content and weight changes concurrently, greater increases in total energy intake (r = 0.08, p = 0.0001) as well as increases in percentage of calories from fat (r = 0.116, p = 0.0001) and decreases in percentage of calories from carbohydrates (r = -0.125, p =0.0001) were all significantly related to weight regain. Decreases in physical activity were also significantly related to weight regain (r = -0.128, p = 0.0001).

To control for the effect of these interrelated and potentially confounding variables, stepwise regression analyses were conducted. Analyses collapsing across cohorts examined whether baseline and/or changes in behaviors (calories, fat intake, protein intake, physical activity, breakfast consumption, fast food consumption) predicted weight regain. Results indicated that baseline calorie intake ($\beta = 0.10$; t =3.2; p = 0.002), fast food consumption ($\beta = 0.10$; t = 3.8, p = 0.0001), and exercise ($\beta = -0.10$; t = -2.3, p = 0.02) were significant independent predictors of weight regain. Increases in energy intake ($\beta = 0.05$; t = 2.1; p = 0.04), increases in the percentage of calories from fat ($\beta = 0.10$; t = 4.4; p = 0.0001; or corresponding decreases in carbohydrate, $\beta = -0.12$; t = -4.7; p = 0.0001), increases in fast food consumption ($\beta = 0.10$; t = 2.5, p = 0.01), and decreases in physical activity ($\beta = -0.12$; t = -4.9; p =0.0001) over 1 year were also independently and significantly related to weight regain, after controlling for potential confounders (i.e., differences in age, duration, weight loss, body weight; R = 0.30; F = 13.7; p = 0.0001).

Discussion

The composition of the diet reported by successful weight loss maintainers entering the NWCR has changed significantly over an 8-year period from 1995 to 2003. In particular, the percentage of calories reported from fat has increased over time and the percentage of calories consumed from carbohydrate has decreased over time, perhaps reflecting a shift in the prevailing dietary recommendations in popular diets. Especially disturbing is the increase in saturated fat that has accompanied the increase in total fat, because saturated fat has been particularly implicated in increasing risk of heart disease (9).

However, healthful improvements in the diet were also observed, including an increase in vegetable consumption to nearly four servings per day and an increase in fiber from vegetables/fruit and beans. In addition, even in later years, the fat content of the diet remained far below national averages (45 vs. 78 g/d, respectively) (10), and the majority were consuming a diet within recommended levels of fat intake. Only a minority consumed a diet that would be considered a low-carbohydrate diet. Nonetheless, these findings suggest that it is possible to maintain energy balance after weight loss on a variety of different types of diets.

It is also important to emphasize that, regardless of the diet consumed, physical activity remained high in all cohorts, exceeding 2000 kcal/wk each year. This level of physical activity corresponds to ~ 60 minutes of moderate intensity physical activity each day, which is consistent with the Institute of Medicine's current physical activity recommendations (11). These findings also complement prior research documenting the importance of physical activity in successful weight loss maintenance (12).

There are several reasons that could explain the changes in diet composition over time among NWCR participants. It is possible that the changes occurred because interest in low-fat diets waned and interest in low-carbohydrate diets increased over the past decade (13). Differences could also reflect sampling bias among participants selecting to enroll in the NWCR or differential attention given to the Registry by weight loss programs and media outlets. Previous studies (14) comparing NWCR participants with a random selection of successful weight losers found similar demographic and behavior characteristics. However, evaluation of trends from randomly selected samples of successful weight losers would be needed to determine whether the findings observed in the current study reflect actual changes in the general population of successful weight losers occurring over time.

Despite the observed changes in macronutrient composition over time, predictors of weight regain remained the same within each cohort. In the sample as a whole and within each year cohort, individuals who had higher calorie intake and fast food consumption and lower physical activity at entry into the study and who increased their calorie, fat, and fast food intake and decreased their physical activity over 1 year regained the most weight. This is consistent with other findings that continued consumption of a low-calorie diet and physical activity are important to long-term success (12,15,16). Because of the high degree of covariance between percentage dietary fat and percentage carbohydrate (-0.81; p = 0.0001), it was not possible to examine independent effects of the two macronutrients. It should be noted, however, that carbohydrate displayed associations precisely opposite to dietary fat, including an inverse effect

on weight regain (i.e., participants who regained weight reported decreases in carbohydrate consumption).

In summary, the level of fat and carbohydrate intake has shifted among successful weight losers in the NWCR over the past decade. While calorie intake has remained stable, fat intake has increased and carbohydrate intake has decreased. These findings suggest that weight control may be possible within a range of macronutrient composition. Across all time-points, however, >75% of NWCR members consumed a diet that was at or below recommended levels of fat intake. In the sample as a whole, maintenance of reduced caloric intake, fat intake, and fast food consumption, as well as high levels of physical activity, were important predictors of long-term successful weight loss and should be considered as potential targets for intervention in future studies of weight regain among successful weight losers.

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