

Behavioural factors related with successful weight loss 15 months post-enrolment in a commercial web-based weight-loss programme

Melinda J Neve^{1,2,*}, Philip J Morgan^{2,3} and Clare E Collins^{1,2}

¹School of Health Sciences, Faculty of Health, University of Newcastle, University Drive, Callaghan, New South Wales 2308, Australia; ²Priority Research Centre in Physical Activity and Nutrition, University of Newcastle, Callaghan, New South Wales, Australia; ³School of Education, Faculty of Education and Arts, University of Newcastle, Callaghan, New South Wales, Australia

Submitted 11 July 2011: Accepted 25 October 2011: First published online 29 November 2011

Abstract

Objective: As further understanding is required of what behavioural factors are associated with long-term weight-loss success, the aim of the present study was to determine the prevalence of successful weight loss 15 months post-enrolment in a commercial web-based weight-loss programme and which behavioural factors were associated with success.

Design: An online survey was completed 15 months post-enrolment in a commercial web-based weight-loss programme to assess weight-related behaviours and current weight. Participants were classified as successful if they had lost $\geq 5\%$ of their starting weight after 15 months.

Setting: Commercial users of a web-based weight-loss programme.

Subjects: Participants enrolled in the commercial programme between August 2007 and May 2008. Six hundred and seventy-seven participants completed the survey.

Results: The median (interquartile range) weight change was -2.7 ($-8.2, 1.6$) % of enrolment weight, with 37% achieving $\geq 5\%$ weight loss. Multivariate logistic regression analysis found success was associated with frequency of weight self-monitoring, higher dietary restraint score, lower emotional eating score, not skipping meals, not keeping snack foods in the house and eating takeaway foods less frequently.

Conclusions: The findings suggest that individuals trying to achieve or maintain $\geq 5\%$ weight loss should be advised to regularly weigh themselves, avoid skipping meals or keeping snack foods in the house, limit the frequency of takeaway food consumption, manage emotional eating and strengthen dietary restraint. Strategies to assist individuals make these changes to behaviour should be incorporated within obesity treatments to improve the likelihood of successful weight loss in the long term.

Keywords
Weight loss
Obesity
Intervention
Internet
Commercial

The worldwide prevalence of overweight and obesity among adults is increasing⁽¹⁾. However, the overall success of behavioural interventions to treat overweight and obesity is moderate⁽²⁾. Successful behavioural weight-loss interventions generally achieve the greatest weight loss after 6 months of treatment (5% to 10%)⁽²⁾. However, weight loss is typically followed by gradual regain of lost weight⁽³⁾. At 2 years post-treatment weight generally stabilises at 5% less than the pre-treatment weight⁽³⁾ and after 5 years more than half of participants will have regained back to their pre-treatment weight, or greater⁽⁴⁾. Therefore, there is a need for treatment strategies that not only promote initial weight loss, but also facilitate long-term maintenance of lost weight.

Web-based weight-loss interventions have emerged in recent years as an alternative or adjunct to traditional treatment mediums. Recent systematic reviews highlight the potential of web-based treatments in achieving significant weight loss^(5–8). However, they have also found that most studies fail to follow up participants beyond the intervention period⁽⁶⁾, so it is not known whether participants who successfully lose weight with web-based programmes can maintain the lost weight.

Currently, commercial programmes are the most accessible web-based weight-loss programmes for consumers⁽⁹⁾. However only one has been rigorously evaluated in two randomised controlled trials (RCT)^(10,11), and neither study followed up participants beyond the intervention period.

*Corresponding author: Email Melinda.Neve@newcastle.edu.au

A small number of other commercial weight-loss programmes have evaluated long-term outcomes⁽¹²⁾ and demonstrated results similar to other lifestyle interventions^(13–16). However, sampling bias is evident in all studies, demonstrated by inclusion of only those participants who successfully lost weight^(14–16) or only evaluating results for women⁽¹³⁾. Therefore, studies to date may misrepresent commercial weight-loss programmes' overall success due to study populations not being representative of all programme participants. There is a need for ongoing research to determine the long-term effectiveness of commercial and web-based weight-loss programmes in groups who are representative of all enrollees.

Previous research has identified behavioural factors that are associated with long-term weight-loss maintenance. These include consistent self-monitoring (e.g. of weight, eating habits and/or physical activity)^(17–20), a physically active lifestyle^(18–21), healthy eating habits such as consuming less dietary fat and regular breakfast consumption⁽²²⁾, limiting the number of meals from fast-food restaurants⁽¹⁹⁾ and appropriate levels of dietary restraint and emotional eating⁽¹⁸⁾. The National Weight Control Registry (NWCR) is the primary study to explore behavioural characteristics associated with weight-loss maintenance⁽²³⁾. However, as the NWCR recruits participants who have lost at least 30 lb (13.6 kg) and maintained that weight loss for at least 1 year⁽²³⁾, it identifies the behavioural factors associated with successful weight loss and/or weight-loss maintenance only in a cohort of initially successful individuals, not all individuals who attempt weight loss or seek treatment. The identification of behavioural factors that are associated with successful weight loss, among all individuals who seek treatment, is imperative to the development of evidence-based strategies to incorporate into obesity treatments or to introduce at the end of weight-loss treatments in order to improve their overall impact in the long term.

Therefore, the aims of the current study were to: (i) examine the prevalence of successful weight loss 15 months post-enrolment in a commercially available web-based weight-loss programme; and (ii) determine behavioural factors associated with successful weight loss 15 months post-enrolment.

Experimental methods

Participants and setting

The commercial web-based weight-loss programme (The Biggest Loser Club Australia) was a 12-week programme, but participants could choose to subscribe for a longer duration to assist with further weight loss and/or maintenance. The programme has been described in detail previously⁽²⁴⁾. Briefly, the web-based platform developed by SP Health Co. incorporated key evidence-based weight-management strategies with features that align

with the key elements of social cognitive theory⁽²⁵⁾ including self-management, social support, self-efficacy, outcome expectations and expectancies, and perceived barriers/facilitators. Enrolees were aged 18–75 years and had a BMI ≥ 22 kg/m², based on self-reported height and weight. Enrolees purchased subscription plan(s) of 1, 3, 4 or 12 months' duration. In 2007/08 a subscription cost \$AUD 16.50–79.95 per month, and was dependent on the number of months a participant subscribed. Participants could subscribe to more than one subscription plan over time and it did not have to be consecutive to the previous subscription. Participants were eligible for inclusion in the current study if they paid for their first subscription between 15 August 2007 and 31 May 2008 and agreed at enrolment to being contacted for possible participation in future research.

Of the 11 341 individuals who paid for their first subscription, 5625 agreed to participate in research and were invited to participate in the online survey (Fig. 1). These individuals were significantly older, had a higher BMI at enrolment and had a lower Index of Relative Socio-economic Advantage and Disadvantage (IRSAD) than those who did not agree to participate in further research ($P < 0.001$). A higher proportion of eligible participants were of Anglo-Saxon descent and a lower proportion was from major cities of Australia ($P < 0.001$).

Recruitment

Eligible participants (n 5625) were invited to participate in an online survey via a personalised email from SP Health Co. sent 15 months after the participants' initial enrolment. The invitation email provided a link to complete the online survey or to opt out if they did not wish to participate. Participants who did not respond to the initial invitation within 2 weeks were sent weekly email reminders for up to 3 weeks. Participants who completed the survey received a free calorie counter valued at \$AUD 7.95.

Twelve per cent (n 677) of eligible participants completed the survey. Sixty-eight per cent did not respond to the survey invitation, 17% did not receive the email invitation to participate, and 3% reported they did not wish to complete the survey. Sixty-three participants were excluded from the analysis as they did not report their weight in the online survey (n 17) or because they were or had been pregnant (n 46) since joining the programme (Fig. 1).

Table 1 describes pre-treatment sociodemographic characteristics by survey response/non-response. Those who completed the survey had a higher baseline BMI and a higher proportion was Anglo-Saxon. It was intended that the survey be completed 15 months post-enrolment (i.e. ~ 450 d). On average the survey was completed 486 d after enrolment, and ranged from 447 to 538 d. Most survey completers (41%) subscribed to the programme for 3 months or less.

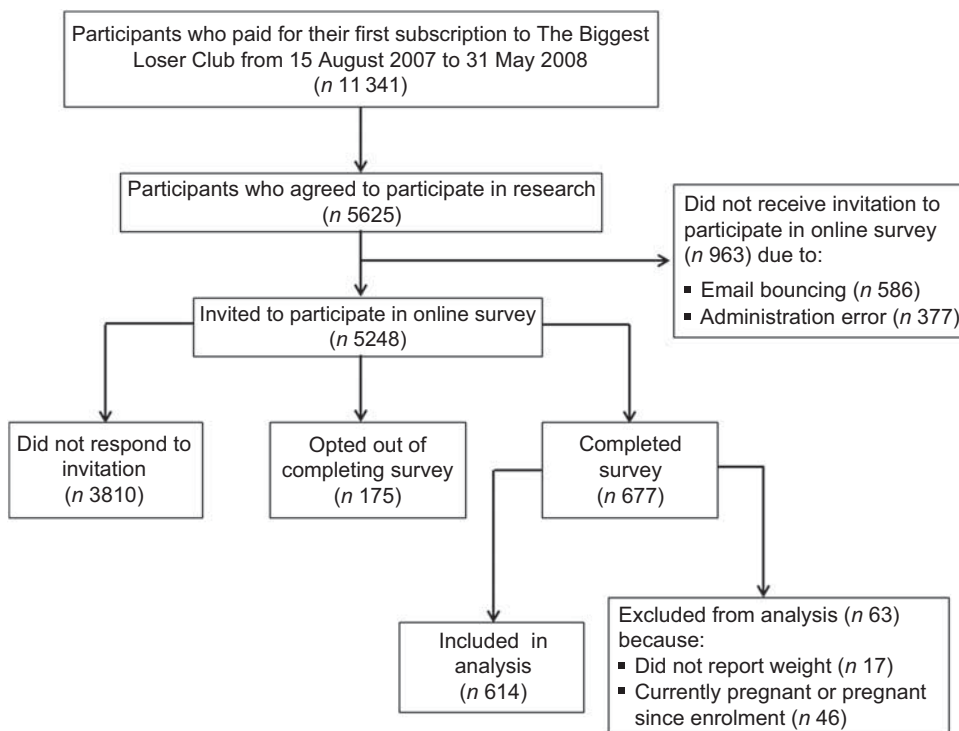


Fig. 1 Participant flow in the study

Table 1 Pre-treatment characteristics of a commercial web-based weight-loss programme cohort by survey completion status, Australia, 2007–2008

	Completed (n 614)		Did not complete (n 5011)		P value
	Median or %	IQR or n	Median or %	IQR or n	
Age (years)*	38.3	32.0, 36.2	35.2	29.0, 41.7	<0.001†
Gender					
Female	88.0	540	87.4	4381	0.71†
Male	12.1	74	12.6	630	
BMI (kg/m ²)*	32.7	29.0, 38.1	32.4	28.5, 37.6	0.07†
Ethnicity					
Anglo-Saxon	73.1	449	63.1	3164	<0.001‡
European	11.2	69	14.9	746	
Other	2.9	18	3.2	161	
Did not wish to respond	12.7	78	18.8	940	
Socio-economic status (IRSAD)					
1–2	6.7	40	6.6	327	0.687‡
3–4	9.3	56	10.1	496	
5–6	20.5	123	18.9	931	
7–8	30.7	184	29.2	1442	
9–10	32.8	197	35.2	1736	
Remoteness (ARIA)					
Major city	73.0	438	74.3	3665	0.356‡
Regional/remote	27.0	162	25.7	1268	

IQR, interquartile range; IRSAD, Index of Relative Socioeconomic Advantage and Disadvantage; ARIA, Accessibility/Remoteness Index of Australia.

*Data are presented as median and IQR.

†Wilcoxon rank-sum test.

‡χ² test.

Data collection

All data were collected by SP Health Co. and provided to the researchers in de-identified form. Data were collected predominantly from the online survey which included thirty-two questions related to the participant’s weight

status, eating and activity behaviours, weight control practices and intervention satisfaction. The survey took participants approximately 10 min to complete. The survey was pilot-tested in a convenience sample of adults (n 10) and refined prior to commencement to ensure that

there was clear and consistent understanding of the questions by respondents, the survey had a logical flow of questions, the administration and data collection were accurate, and to determine the average time taken to complete the survey. Additional data utilised for the study included responses from a pre-treatment survey completed during enrolment to the programme, which included self-reported anthropometric and demographic data. Data regarding the membership history of each participant within the initial 15 months of membership (e.g. date of enrolment, date membership ceased and the type of subscription plans held) were also collected.

Ethics approval for the study was obtained from the University of Newcastle Human Research Ethics Committee.

Weight-loss success

Weight change (absolute and percentage) achieved at 15 months post-enrolment was calculated by subtracting the participants' weight reported in the online survey from their pre-treatment weight. Participants were categorised as successful if they achieved a percentage weight loss of $\geq 5\%$ from enrolment to 15 months. A weight loss of $\geq 5\%$ was selected as it has previously been recommended as the criterion to evaluate weight-management programmes⁽²⁶⁾, and has also been shown to be associated with improvements in weight-related morbidity, particularly reduced incidence of type 2 diabetes mellitus^(10,27,28).

Behavioural factors

The online survey included short dietary questions, previously developed and validated as part of the Australian National Nutrition Survey^(29,30), to ascertain frequency and/or quantity of current intake of key foods and food groups (breakfast, takeaway food, restaurant meals, soda, fruit and vegetables). Participants were also asked if they currently partook in specific eating habits (i.e. Do you do any of the following? Please tick all that apply. Fry foods; Use butter in cooking; Drink tea or coffee with sugar; Use low-fat products where possible; Skip meals; Keep snack foods in the house; Drink 6 or more glasses of water per day).

Responses to two questions regarding current frequency and quantity of alcohol consumption categorised usual alcohol intake related risk⁽³¹⁾. Alcohol intake was defined as 'low risk' if a maximum of one to two drinks were consumed on any drinking occasion, as 'moderate risk' if three to four drinks were consumed on any drinking occasion, as 'high risk' if more than four drinks were consumed on any drinking occasion, or as 'no risk' if the participant did not consume alcohol.

Dietary restraint, emotional and uncontrolled eating were assessed using the Three Factor Eating Questionnaire-R18, and scores were calculated as previously described by Karlsson *et al.*⁽³²⁾.

Physical activity level was estimated using the validated International Physical Activity Questionnaire (IPAQ) short

format⁽³³⁾. Responses were categorised as low, moderate or high levels of physical activity based on the estimated time spent walking or in moderate or vigorous intensity activity in the previous 7 d⁽³⁴⁾. The number of minutes participants reported sitting per day was used as a marker of sedentary behaviour. Current frequency of self-monitoring of weight, food and exercise were independently assessed on a 7-point Likert scale ranging from never to several times daily.

Confounders

Sociodemographic characteristics from the pre-treatment survey included anthropometric (weight and height) and demographic (age, gender and postcode) data. Self-reported height and weight were used to calculate BMI (weight (kg)/[height (m)]²). Reported postcodes were assigned an IRSAD category (1–10)⁽³⁵⁾ as an indicator of socio-economic status, as well as an Accessibility/Remoteness Index of Australia (ARIA)⁽³⁶⁾ to classify the level of remoteness of the area in which the participant lived.

The total number of different weight-loss strategies used in the previous 15 months, other than the website, were calculated (e.g. other commercial programmes, meal replacements, fad diets, diet books or manuals, other web-based programmes, surgery, medications, consultations with health professionals). Satisfaction with the commercial web-based weight-loss programme was also assessed using a 5-point Likert scale ranging from extremely satisfied to extremely dissatisfied.

Data analysis

Data analysis was undertaken using the STATA statistical software package version 11.0 (StataCorp, College Station, TX, USA), with *P* values less than 0.01 considered statistically significant due to the large number of comparisons being made. Basic descriptive statistics (median and interquartile range (IQR) for continuous variables, percentages for categorical variables) were used to describe participants' sociodemographic characteristics at enrolment, weight change from baseline to 15 months, programme-related factors and behavioural factors. Categorical variables were collapsed to a smaller number of responses if a low number of participants responded in the extremes of the response range. Differences in sociodemographic characteristics at enrolment of survey responders/non-responders, as well as differences in behavioural factors and potential confounders between successful and unsuccessful participants, were tested using the two-sample *t* test for normally distributed or the Wilcoxon rank-sum test for non-normally distributed continuous variables and the χ^2 test for categorical variables. Differences in weight change (absolute and percentage) from baseline to 15 months by length of membership in the programme (≤ 6 months, >6 to ≤ 12 months, >12 months) were tested using the Kruskal–Wallis test for equality of populations for continuous variables and the χ^2 test for

categorical variables. Univariate logistic regression was conducted to assess the association of behavioural factors with successful weight loss. Behavioural factors with $P < 0.2$ were tested for inclusion in the multiple logistic regression model using a stepwise approach. Socio-demographic and programme-related factors found to be significantly associated with weight-loss success in the univariate analysis were also included in the multiple logistic regression model due to potential confounding as well as known confounders (baseline BMI, age, ethnicity, gender). If any two behavioural or confounding factors were found to be significantly correlated ($P < 0.05$, $r > 0.7$), the factor most significantly associated with successful weight loss from the univariate analysis was included in the model. Self-monitoring of food and self-monitoring of exercise had a significant association ($r = 0.80$), as did the total number of membership days and the number of days since enrolment ($r = 0.79$). Therefore, self-monitoring of exercise and the total number of membership days were tested in the multivariate model.

Participants who completed the online survey but did not report their weight ($n = 17$), or who reported that they were currently pregnant or had been pregnant in the previous 15 months ($n = 46$), were excluded from the analysis.

Results

Prevalence of successful weight loss

The median (IQR) 15-month weight change was -2.0 ($-8.0, -1.8$) kg or -2.7% of enrolment weight. Just over a third of participants (37%) achieved a weight loss of $\geq 5\%$ and therefore classified as successful (Table 2).

The degree of weight loss increased significantly as the length of membership increased. That is, a median (IQR) weight change of -4.4 ($-10.7, -0.5$)% was achieved by those who were members for >12 months, with 47% achieving a weight loss of $\geq 5\%$, whereas a median (IQR) weight change of -0.9 ($-5.7, -2.9$)% was achieved by those who were members for ≤ 3 months, of whom 28% achieved a $\geq 5\%$ weight loss.

Differences between successful and unsuccessful participants

Table 3 describes differences in sociodemographic characteristics and programme-related factors by successful and unsuccessful participants. Successful participants had been a member of the programme for significantly more days, and therefore completed the survey fewer days since their last membership. Successful participants were less likely to have used other weight-loss strategies in the previous 15 months.

Table 4 describes differences in behavioural factors by successful and unsuccessful participants. A higher proportion of successful participants reported more frequent self-monitoring of weight, dietary intake and exercise. A higher proportion of successful participants met the recommended intake targets for vegetable and fruit consumption (i.e. respectively five and two servings daily).

Successful participants were less likely to report unhealthy eating habits such as skipping meals, keeping snack foods in the house, eating takeaway foods, drinking soft drinks and not regularly consuming breakfast. Successful participants also had significantly lower uncontrolled and emotional eating scores, as well as higher dietary restraint scores. A higher proportion of successful participants reported high levels of physical activity.

Table 2 Self-reported weight change from enrolment to 15 months in a commercial web-based weight-loss programme cohort, Australia, 2007–2008

Weight change from enrolment to 15 months	Membership length (months)									
	Total (n 614)		≤ 3 (n 249)		>3 to ≤ 6 (n 91)		>6 to ≤ 12 (n 91)		>12 (n 183)	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Median	IQR
Absolute† (kg)	-2.0	8.0, 1.8	-1.0	-5.0, 2.2	-1.2	-6.0, 1.4	-4.0	-10.1, 0.0	-3.9	-12.0, 0.5
Percentage of baseline (%)*	-2.7	-8.2, 1.6	-0.9	-5.7, 2.9	-1.7	-6.5, 1.7	-3.9	-11.1, 0.0	-4.4	-10.7, 0.5
		%		%		%		%		%
Percentage change from baseline by defined categories†										
>0%	33.9		39.8		38.5		24.2		28.4	
≤ 0 to $> -5\%$	29.5		32.5		27.5		31.9		25.1	
$\leq -5\%$ to $> -10\%$	16.1		14.9		16.5		12.1		19.7	
$\leq -10\%$ to $> -15\%$	10.9		8.8		5.5		19.8		12.0	
$\leq -15\%$	9.6		4.0		12.1		12.1		14.8	

IQR, interquartile range.

*Significant difference ($P = 0.001$) between membership length categories (Kruskal–Wallis test).

†Significant difference ($P < 0.001$) between membership length categories (χ^2 test).

Table 3 Sociodemographic and intervention factors by successful and unsuccessful participants in a commercial web-based weight-loss programme cohort, Australia, 2007–2008

	Successful (<i>n</i> 225)		Unsuccessful (<i>n</i> 389)		<i>P</i> value
	Median or %	IQR or <i>n</i>	Median or %	IQR or <i>n</i>	
Age (years)*	38.0	31.5, 45.7	38.5	32.0, 46.3	0.86†
Gender					
Female	85.3	192	89.5	348	0.13‡
Male	14.7	33	10.5	41	
BMI (kg/m ²)*	34.1	29.4, 39.4	32.3	28.7, 36.8	0.02†
Ethnicity					
Anglo-Saxon	74.2	167	72.5	282	0.054‡
European	13.8	31	9.8	38	
Other	3.6	8	2.6	10	
Did not wish to respond	8.4	19	15.2	59	
Socio-economic status (IRSAD)					
1–2	6.4	14	6.8	26	0.93‡
3–4	10.5	23	8.7	33	
5–6	20.5	45	20.5	78	
7–8	29.1	64	31.6	120	
9–10	33.6	74	32.4	123	
Remoteness (ARIA)					
Major city	74.6	164	72.1	274	0.51‡
Regional/remote	25.5	56	27.9	106	
Days since enrolment*	484	470, 494	488	474, 499	<0.001†
Days a member in previous 15 months*	214	92, 395	121	91, 366	<0.001†
Days since last membership*	126	0, 379	333	84, 396	<0.001†
Other weight-loss strategies used in the previous 15 months					
None	47.1	106	34.7	135	<0.001‡
1	35.1	79	30.6	119	
2	12.0	27	17.5	68	
3 or more	5.8	13	17.2	67	
Intervention satisfaction					
Satisfied	79.6	179	70.2	273	0.03‡
Neutral	17.3	39	23.9	93	
Dissatisfied	3.1	7	5.9	23	

IQR, interquartile range.

*Values are presented as median and IQR.

†Wilcoxon rank-sum test.

‡ χ^2 test.

Multivariate analysis of successful weight loss

Table 5 outlines the behavioural factors found to be independently associated with successful weight loss. Compared with participants who reported weighing themselves infrequently (never to less than once monthly), those who weighed themselves more frequently were more likely to be successful. Participants who weighed themselves less than once weekly but more than once monthly had the highest odds of being successful. Participants who reported they ate takeaway foods less than once weekly, particularly those who never consumed takeaway foods, were more likely to be successful. Participants who did not skip meals or keep snack foods in the house, as well as those with higher dietary restraint scores were also significantly more likely to be successful. The higher a participant's emotional eating score the less likely he/she was to be successful.

Discussion

The first aim of the current study was to examine the prevalence of successful weight loss at 15 months

post-enrolment in a commercial web-based weight-loss programme. The study is one of only a small number^(13–16) to investigate the long-term weight loss achieved by participants of a commercial weight-loss programme, and the first to evaluate this for a commercial web-based programme. We found that just over a third of participants achieved a weight loss of $\geq 5\%$ at 15 months post-enrolment. The study also identified key behavioural factors that were associated with the likelihood of successful weight loss 15 months post-enrolment. These included regular self-monitoring of weight, not skipping meals, not keeping snack foods in the house, infrequent takeaway food consumption, less emotional eating and greater dietary restraint. These findings highlight strategies that can be incorporated in treatment programmes in an attempt to improve long-term weight loss.

Over one third of participants achieved a clinically important weight loss at 15 months post-enrolment, thereby reducing their risk of weight-related morbidity such as type 2 diabetes mellitus^(27,28). Furthermore, the proportion of participants who achieved $\geq 5\%$ weight loss increased significantly as membership length increased.

Table 4 Prevalence and risk of behavioural factors by successful and unsuccessful participants in a commercial web-based weight-loss programme cohort, Australia, 2007–2008

	Successful (<i>n</i> 225)		Unsuccessful (<i>n</i> 389)		<i>P</i> value
	%	<i>n</i>	%	<i>n</i>	
Self-monitoring: Weight					
<1 time/month or never	11.1	25	26.2	102	<0.001*
<1 time/week	9.8	22	7.7	30	
1 time/week	38.7	87	30.6	119	
>1 time/week	21.8	49	17.7	69	
≥1 time/d	18.7	42	17.7	69	
Self-monitoring: Food					
<1 time/month or never	47.6	107	60.2	234	0.002*
<1 time/week	4.9	11	6.2	24	
1 time/week	4.0	9	5.4	21	
>1 time/week	12.4	28	10.5	41	
≥1 time/d	31.1	70	17.7	69	
Self-monitoring: Exercise					
<1 time/month or never	43.1	97	59.4	231	<0.001*
<1 time/week	6.2	14	5.1	20	
1 time/week	7.1	16	5.7	22	
>1 time/week	12.0	27	12.6	49	
≥1 time/d	31.6	71	17.2	67	
Vegetable intake					
<2 servings/d	35.6	80	48.3	188	0.009*
2–4 servings/d	50.2	113	40.1	156	
≥5 servings/d	14.2	32	11.6	45	
Fruit intake					
<1 serving/d	22.7	51	31.9	124	0.026*
1 serving/d	33.3	75	33.2	129	
≥2 servings/d	44.0	99	35.0	136	
Do you fry foods?					
Yes	19.6	44	26.5	103	0.053*
No	80.4	181	73.5	286	
Do you use butter in cooking?					
Yes	19.6	44	27.3	106	0.033*
No	80.4	181	72.8	283	
Do you skip meals?					
Yes	21.8	49	42.4	165	<0.001*
No	78.2	176	57.6	224	
Do you drink tea or coffee with sugar?					
Yes	28.4	64	32.9	128	0.251*
No	71.6	161	67.1	261	
Do you use low-fat products?					
Yes	87.1	196	79.4	309	0.016*
No	12.9	29	20.6	80	
Do you keep snack foods in the house?					
Yes	27.1	61	44.0	171	<0.001*
No	72.9	164	56.0	218	
Drink 6+ glasses of water a day?					
Yes	62.7	141	44.0	171	0.108*
No	37.3	84	56.0	218	
Breakfast consumption frequency					
<5 d/week	9.8	22	22.0	85	<0.001*
≥5 d/week	90.2	202	78.0	302	
Soft drinks consumption frequency					
>1/d	6.3	14	9.0	35	0.004*
1/d	5.8	13	8.8	34	
<1/d	21.0	47	30.4	118	
Never	67.0	150	51.8	201	
Takeaway food consumption frequency					
>1 time/week	7.6	17	25.3	98	<0.001*
1 time/week	20.1	45	20.6	80	
1–3 times/month	38.4	86	29.9	116	
1 time/month	24.1	54	18.3	71	
Never	9.8	22	5.9	23	
Restaurant food consumption frequency					
>1 time/week	7.6	17	10.8	42	0.705*
1 time/week	14.7	33	13.1	51	
1–3 times/month	32.1	72	33.3	129	
1 time/month	35.7	80	33.0	128	
Never	9.8	22	9.8	38	

Table 4 *Continued*

	Successful (<i>n</i> 225)		Unsuccessful (<i>n</i> 389)		<i>P</i> value
	%	<i>n</i>	%	<i>n</i>	
Alcohol intake					
High risk	11.2	25	12.4	48	0.924*
Moderate risk	20.5	46	18.8	73	
Low risk	51.3	115	52.6	204	
No risk	17.0	38	16.2	63	
Physical activity level					
Low	28.5	61	41.7	148	0.002*
Moderate	41.1	88	38.3	136	
High	30.4	65	20.0	71	
Time spent sitting (min/d)					
Median	300		360		0.04†
IQR	161, 480		180, 500		
Restraint score					
Mean	15.2		14.4		<0.001‡
SD	2.0		2.0		
Emotional eating score	7.2		8.4		<0.001‡
Mean	2.5		2.5		
SD					
Uncontrolled eating score					<0.001†
Median	20		22		
IQR	18, 22		19, 24		

* χ^2 test.

†Wilcoxon rank-sum test.

‡Two-sample *t* test.**Table 5** Behavioural factors independently associated with successful weight loss in a commercial web-based weight-loss programme cohort, Australia, 2007–2008

	OR	95% CI	<i>P</i> value
Self-monitoring of weight			
<1 time/week	4.31	1.88, 9.85	0.001
1 time/week	2.66	1.45, 4.87	0.002
>1 time/week	2.95	1.50, 5.80	0.002
≥ 1 time/d	3.01	1.50, 6.05	0.002
Do you skip meals?			
No	2.18	1.39, 3.41	0.001
Do you keep snack foods in the house?			
No	1.97	1.28, 3.02	0.002
Takeaway food consumption frequency			
1–3 times/month	3.63	1.84, 7.17	<0.001
1 time/month	3.31	1.54, 7.11	0.002
Never	4.56	1.72, 12.08	0.002
Eating patterns score			
Dietary restraint	1.18	1.06, 1.31	0.002
Emotional eating	0.84	0.77, 0.91	<0.001

Adjusted for gender, baseline BMI, age, ethnicity, days since membership, total membership days, intervention satisfaction and number of other weight-loss strategies (*n* 601).

As many participants (41%) subscribed to the programme for less than 3 months, a potential strategy to improve long-term weight loss is to encourage participants to subscribe for longer or to offer a longer (e.g. 6 months) minimum subscription length. This is consistent with other research which suggests that the greatest level of weight loss is achieved after 6 months of treatment⁽²⁾. It is noteworthy that over 60% of the participants who subscribed for 3 months or less had not regressed to their enrolment weight after 1 year, as is commonly the case for

behavioural weight-loss programmes⁽²⁾. This suggests that a short-term web-based weight-loss programme has the potential to achieve modest weight loss 1 year post-enrolment and prevent weight gain. However, this must be further tested prospectively and objectively in an RCT.

Notably only two RCT^(37,38) and one observational study⁽³⁹⁾ have assessed participants' maintenance of weight loss following the completion of a web-based weight-loss intervention. Morgan *et al.* reported a -5.3 kg weight change at 9 months post-completion of a 3-month

web-based intervention, with 58% of participants achieving a weight loss of $\geq 5\%$ ⁽³⁷⁾. Rotherth *et al.* reported significantly greater weight-loss maintenance in a tailored Internet group (-2.7 and -3.0%) compared with an information-only Internet group (-1.2 and -1.2%) at 3 and 6 months post-enrolment in a 6-week intervention⁽³⁸⁾. Wing *et al.* reported an average weight loss of -3.8% in overweight and obese participants 2 months post-completion of a 16-week web-based intervention⁽³⁹⁾. The magnitude of long-term weight loss reported in the current study may appear low in comparison to the other studies. However, those studies evaluated weight change only within a short time frame after completion of the intervention (2 to 9 months), and the interventions also included non-web-based components (e.g. face-to-face sessions, resources)^(37–39). As many survey participants (41%) in the present study subscribed to the programme for 3 months or less, many had not participated in the programme for approximately 1 year when they completed the survey; therefore the results are noteworthy.

The results from long-term follow-up studies of commercial weight-loss programmes have been varied. Approximately 44% of female participants of Mincavi, a group-based face-to-face programme, maintained $\geq 5\%$ weight loss after 2 years⁽¹³⁾. Weight Watchers, a group based face-to-face programme, reported that 70–80% of participants who achieved their goal weight maintained $\geq 5\%$ weight loss after 1 year^(14,15). The Jenny Craig programme, which involves weekly face-to-face individual and group consultations, has reported that among participants who achieved their goal weight, an average weight loss of 12.5 kg was sustained after 1 year⁽¹⁶⁾. The prevalence of successful weight loss reported in the current study may appear low in comparison to other long-term follow-up studies of commercial weight-loss programmes. However, the participants in the comparison studies are not representative of all enrollees, with three of the studies only including participants who were initially successful at achieving significant weight loss^(13–16) and the other study only including female participants⁽¹³⁾. Therefore, the results cannot be generalised to the whole population of their respective commercial users in terms of degree of long-term weight loss. More specifically, those studies that only include participants who were initially successful may overestimate the true prevalence of long-term weight loss.

The second aim of our study was to determine behavioural factors associated with successful weight loss 15 months post-enrolment. We found in a univariate analysis that twelve different behavioural factors were associated with successful weight loss 15 months post-enrolment. However, only six behavioural factors were independently associated with success. This suggests that there were six key drivers (self-monitoring of weight, skipping meals, keeping snack food in the house, frequency takeaway food consumption, restrained eating

and emotional eating) to long-term weight-loss success in this cohort. It is likely that the other six factors that were not independently associated with success were related to these six key drivers (e.g. skipping meals and breakfast consumption frequency).

Self-monitoring of weight was associated with successful weight loss, which is consistent with previous research that has demonstrated more frequent self-weighing (daily or weekly) is associated with improved weight-loss maintenance^(19,40–42). However, these studies often do not differentiate between less frequent self-weighing categories, and group frequencies such as less than once per month and less than once per week together. Our study included a greater number of self-weighing frequency categories and demonstrated that participants who weighed themselves less than once per week, but more often than once per month, had the greatest odds of being successful. This suggests that more frequent self-weighing (e.g. one or more times per week or day) may not be essential to achieve clinically important weight loss in the long term.

Eating patterns play an important role in long-term weight-loss success, with higher levels of dietary restraint and lower levels of emotional eating associated with maintenance of lost weight^(40,43–46). The results from our study are consistent, demonstrating that for each 1 point increase in the emotional eating score, the likelihood of being successful decreased by 16%, whereas for each 1 point increase in restraint score the likelihood of being successful increased by 18%. Therefore, strategies to assist individuals to manage emotional eating and to strengthen dietary restraint are required. Recent studies have demonstrated that behavioural interventions can produce positive changes to participants' eating patterns⁽⁴⁴⁾ but further research is required to determine the most effective strategies to ensure long-term weight loss.

Previous studies have demonstrated that successful weight loss is associated with consistent eating patterns and regular breakfast consumption^(22,47). While unable to demonstrate that consuming breakfast was significantly associated with success, we found that skipping meals was associated with a lack of success. Therefore, it may not be skipping breakfast that is the problem behaviour, but rather skipping any meals. The current study also suggests that the availability of snack foods within the home environment may also negatively affect weight loss. Finally, our study suggests that reducing takeaway food consumption to less than once per week significantly increases the likelihood of successful weight loss, with no takeaway food consumption being most ideal, which is also consistent with previous research⁽¹⁹⁾.

Limitations

To maximise external validity our study aimed to recruit participants who were representative of the consumers who enrol in a commercial web-based weight-loss programme.

Therefore, inclusion in our study was not dependent on achieving a goal weight or having a significant weight loss or whether individuals completed or used the web-based programme, as is the case with other similar studies. Survey responders were similar to non-responders for most pre-treatment characteristics. However, programme enrollees who agreed to be contacted to participate in research were older, with higher BMI, of lower socio-economic status, and more likely to be Anglo-Saxon or from regional/remote areas of Australia. The response rate to the online survey was also low. However, a similar study that followed up participants 12 months post-enrolment in a web-based weight-loss programme via an online survey achieved a similar response rate (15%)⁽⁴⁸⁾. Therefore, the results of our study may misrepresent the prevalence of successful weight loss 15 months post-enrolment among all programme enrollees. The response rate and representativeness of future research could potentially be improved with different recruitment strategies, offering alternative methods of survey completion (e.g. telephone, mail) or greater incentives.

Another potential limitation of the present study is that all outcomes were self-reported. To reduce measurement bias, validated questionnaires (e.g. IPAQ, Three Factor Eating Questionnaire-R18, short diet questions) were used where possible. Self-reported weight data were used to evaluate success, and weight can be under-reported⁽⁴⁹⁾. However, self-reported weight recorded by participants of a web-based weight-loss programme has been found to be accurate compared with measured weight⁽⁵⁰⁾.

The study also considered behavioural factors cross-sectionally and did not capture pre-treatment or changes in behaviours. Therefore, the analysis demonstrated which behaviours at 15 months were associated with successful weight loss but did not determine whether the participants improved their behaviour to achieve weight loss, or behavioural characteristics remained the same and success could have been predicted at baseline. Furthermore, the analysis adjusted for intervention-related factors (e.g. number of membership days, other weight-loss strategies used), but the study did not examine whether these intervention-related factors influenced the behavioural factors associated with successful weight loss, and this could be an area of future research.

Conclusions

The findings suggest that over one third of participants in a commercial web-based weight-loss programme achieved clinically important weight loss 15 months post-enrolment, and that participating in the programme for 6 months or longer was associated with greater weight loss. The findings also provide support for existing recommendations, as well as propose novel strategies, to be incorporated within obesity treatments to improve the

likelihood of successful weight-loss outcomes in the long term. More specifically the findings suggest individuals trying to achieve or maintain $\geq 5\%$ weight loss should be advised to regularly weigh themselves, avoid skipping meals or keeping snack foods in the house, and limit the frequency of takeaway food consumption. Furthermore, strategies to assist individuals to manage emotional eating and to strengthen dietary restraint should also be incorporated within obesity treatments.

Acknowledgements

Sources of funding: This study was supported by an Australian Postgraduate Award (M.J.N.), a scholarship top-up from SP Health Co. Pty Ltd (M.J.N.) and an Australian National Health and Medical Research Council Career Development Award research fellowship (C.E.C.). *Potential conflicts of interest:* M.J.N. received a post-graduate scholarship top-up from SP Health Co. C.E.C. was a consultant dietitian to SP Health Co. P.J.M. and C.E.C. hold an Australian Research Council (ARC) Linkage project grant that is evaluating a weight-loss programme with SP Health Co. *Author contributions:* All authors were responsible for the study design, and reviewing, editing and approving the final version of the manuscript. M.J.N. conducted the statistical analysis and drafted the manuscript. *Acknowledgements:* The authors acknowledge the work of Ben Noblet in retrieving the data, Anna Crook and Penelope Jones for assistance with interpreting the data set, and Emma Julian for management of the online survey.

References

- Ogden CL, Yanovski SZ, Carroll MD *et al.* (2007) The epidemiology of obesity. *Gastroenterology* **132**, 2087–2102.
- Perri M & Corsica J (2002) Improving the maintenance of weight lost in behavioural treatment of obesity. In *Handbook of Obesity Treatment*, pp. 357–379 [T Wadden and A Stunkard, editors]. New York: Guilford Press.
- Levy RL, Finch EA, Crowell MD *et al.* (2007) Behavioural intervention for the treatment of obesity: strategies and effectiveness data. *Am J Gastroenterol* **102**, 2314–2321.
- Wadden TA, Crerand CE & Brock J (2005) Behavioural treatment of obesity. *Psychiatr Clin North Am* **28**, 151–170.
- Arem H & Irwin M (2010) A review of web-based weight loss interventions in adults. *Obes Rev* **12**, e236–e243.
- Neve M, Morgan PJ, Jones PR *et al.* (2010) Effectiveness of web-based interventions in achieving weight loss and weight loss maintenance in overweight and obese adults: a systematic review with meta-analysis. *Obes Rev* **11**, 306–321.
- Saperstein SL, Atkinson NL & Gold RS (2007) The impact of Internet use for weight loss. *Obes Rev* **8**, 459–465.
- Weinstein PK (2006) A review of weight loss programs delivered via the Internet. *J Cardiovasc Nurs* **21**, 251–258.
- Krukowski RA, West DS & Harvey-Berino J (2009) Recent advances in Internet-delivered, evidence-based weight control programs for adults. *J Diabetes Sci Technol* **3**, 184–189.
- Womble LG, Wadden TA, McGuckin BG *et al.* (2004) A randomised controlled trial of a commercial Internet weight loss program. *Obes Res* **12**, 1011–1018.

11. Gold BC, Burke S, Pintauro S *et al.* (2007) Weight loss on the web: a pilot study comparing a structured behavioural intervention to a commercial program. *Obesity (Silver Spring)* **15**, 155–164.
12. Tsai AG & Wadden TA (2005) Systematic review: An evaluation of major commercial weight loss programs in the United States. *Ann Intern Med* **142**, 56–66.
13. Gosselin C & Cote G (2001) Weight loss maintenance in women two to eleven years after participating in a commercial program: a survey. *BMC Womens Health* **1**, 2.
14. Lowe MR, Kral TVE & Miller-Kovach K (2008) Weight loss maintenance 1, 2 and 5 years after successful completion of a weight loss programme. *Br J Nutr* **99**, 925–930.
15. Lowe MR, Miller-Kovach K & Phelan S (2001) Weight loss maintenance in overweight individuals one to five years following successful completion of a commercial weight loss program. *Int J Obes Relat Metab Disord* **25**, 325–331.
16. Wolfe BL (1992) Long-term maintenance following attainment of goal weight: a preliminary investigation. *Addict Behav* **17**, 469–477.
17. Butryn ML, Phelan S, Hill JO *et al.* (2007) Consistent self-monitoring of weight: a key component of successful weight loss maintenance. *Obesity (Silver Spring)* **15**, 3091–3096.
18. Elfhag K & Rössner S (2005) Who succeeds in maintaining weight loss? A conceptual review of factors associated with weight loss maintenance and weight regain. *Obes Rev* **6**, 67–85.
19. Kruger J, Blanck HM & Gillespie C (2006) Dietary and physical activity behaviours among adults successful at weight loss maintenance. *Int J Behav Nutr Phys Act* **3**, 17.
20. Wing RR & Hill JO (2001) Successful weight loss maintenance. *Annu Rev Nutr* **21**, 323–341.
21. Catenacci VA, Grunwald GK, Ingebrigtsen JP *et al.* (2011) Physical activity patterns using accelerometry in the National Weight Control Registry. *Obesity (Silver Spring)* **19**, 1163–1170.
22. Wyatt HR, Grunwald GK, Mosca CL *et al.* (2001) Long-term weight loss and breakfast in subjects in the National Weight Control Registry. *Obes Res* **10**, 78–82.
23. Hill JO, Wyatt H, Phelan S *et al.* (2005) The National Weight Control Registry: is it useful in helping deal with our obesity epidemic? *J Nutr Educ Behav* **37**, 206–210.
24. Neve MJ, Collins CE & Morgan PJ (2010) Dropout, nonusage attrition, and pretreatment predictors of nonusage attrition in a commercial web-based weight loss program. *J Med Internet Res* **12**, e69.
25. Bandura A (1986) *Social Foundations of Thought and Action: A Social Cognitive Theory*. Englewood Cliffs, NJ: Prentice-Hall.
26. Thomas P (1995) *Weighing the Options: Criteria for Evaluating Weight-Management Programs*. Washington, DC: National Academy Press.
27. Knowler WC, Barrett-Connor E, Fowler SE *et al.* (2001) Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. *N Engl J Med* **346**, 393–403.
28. National Health and Medical Research Council (2003) *Clinical Practice Guidelines for the Management of Overweight and Obesity in Adults*. Canberra: NHMRC.
29. Rutishauser I, Webb K, Abraham B *et al.* (2001) *Evaluation of Short Diet Questions from the 1995 National Nutrition Survey*. Canberra: Australian Food and Nutrition Monitoring Unit.
30. Marks G, Webb K, Rutishauser I *et al.* (2001) *Monitoring Food Habits in the Australian Population Using Short Questions*. Canberra: Australian Food and Nutrition Monitoring Unit.
31. National Health and Medical Research Council (2009) *Australian Guidelines to Reduce Health Risks from Drinking Alcohol*. Canberra: NHMRC.
32. Karlsson J, Persson LO, Sjostrom L *et al.* (2000) Psychometric properties and factor structure of the Three-Factor Eating Questionnaire (TFEQ) in obese men and women. Results from the Swedish Obese Subjects (SOS) study. *Int J Obes Relat Metab Disord* **24**, 1715–1725.
33. Craig CL, Marshall AL, Sjostrom M *et al.* (2003) International Physical Activity Questionnaire: 12-country reliability and validity. *Med Sci Sports Exerc* **35**, 1381–1395.
34. IPAQ Research Committee (2005) Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ) – Short and Long Forms. <http://www.ipaq.ki.se/scoring.pdf> (accessed July 2010).
35. Australian Bureau of Statistics (2006) *Information Paper: An Introduction to Socio-Economic Indexes for Areas (SEIFA)*. Canberra: ABS.
36. Australian Bureau of Statistics (2008) *Australian Standard Geographical Classification (ASGC)*. Canberra: ABS.
37. Morgan PJ, Lubans DR, Collins CE *et al.* (2010) 12-month outcomes and process evaluation of the SHED-IT RCT: an Internet-based weight loss program targeting men. *Obesity (Silver Spring)* **19**, 142–151.
38. Rothert K, Strecher VJ, Doyle LA *et al.* (2006) Web-based weight management programs in an integrated health care setting: a randomized, controlled trial. *Obesity (Silver Spring)* **14**, 266–272.
39. Wing RR, Pinto AM, Crane MM *et al.* (2009) A statewide intervention reduces BMI in adults: Shape Up Rhode Island results. *Obesity (Silver Spring)* **17**, 991–995.
40. McGuire MT, Wing RR, Klem ML *et al.* (1999) Behavioural strategies of individuals who have maintained long-term weight losses. *Obes Res* **7**, 334–341.
41. Vanwormer JJ, French SA, Pereira MA *et al.* (2008) The impact of regular self-weighing on weight management: a systematic literature review. *Int J Behav Nutr Phys Act* **5**, 54.
42. Wing RR, Tate DF, Gorin AA *et al.* (2007) STOP regain: are there negative effects of daily weighing? *J Consult Clin Psychol* **75**, 652–656.
43. Butryn ML, Thomas JG & Lowe MR (2009) Reductions in internal disinhibition during weight loss predict better weight loss maintenance. *Obesity (Silver Spring)* **17**, 1101–1103.
44. Teixeira PJ, Silva MN, Coutinho SR *et al.* (2010) Mediators of weight loss and weight loss maintenance in middle-aged women. *Obesity (Silver Spring)* **18**, 725–735.
45. Vogels N & Westerterp-Plantenga M (2007) Successful long-term weight maintenance: a 2-year follow-up. *Obesity (Silver Spring)* **15**, 1258–1266.
46. Niemeier HM, Phelan S, Fava JL *et al.* (2007) Internal disinhibition predicts weight regain following weight loss and weight loss maintenance. *Obesity (Silver Spring)* **15**, 2485–2494.
47. Gorin A, Phelan S, Wing R *et al.* (2004) Promoting long-term weight control: does dieting consistency matter? *Int J Obes Relat Metab Disord* **28**, 278–281.
48. Couper MP, Peytchev A, Strecher VJ *et al.* (2007) Following up nonrespondents to an online weight management intervention: randomised trial comparing mail versus telephone. *J Med Internet Res* **9**, e16.
49. Conner Gorber S, Tremblay M, Moher D *et al.* (2007) A comparison of direct vs. self report measures for assessing height, weight and body mass index: a systematic review. *Obes Rev* **8**, 307–326.
50. Harvey-Berino J, West D, Buzzell P *et al.* (2008) Weight reported on the web: is it accurate? *Obesity (Silver Spring)* **16**, Suppl. 1S, S97–S182.