



Weight Loss and Attrition in Overweight and Obese Young Women During a 36-Week Internet-Based Lifestyle Intervention

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Abstract

Background: Young women are at high risk of weight gain yet few studies have examined the long-term effectiveness of weight loss programs in this group. This study aimed to investigate the effects of a self-directed internet-based lifestyle program on body weight in young women.

Methods: Overweight or obese young women (BMI 33.4 ± 0.3 kg/m², age 27.8 ± 0.3 years) were initially randomized to General lifestyle advice (G) or Structured lifestyle advice (S) via in-person and website support for 12 weeks (Phase I). After Phase I, all participants were supported through a self-directed internet-based program for 36 weeks (Phase II). The internet-based program included a structured hypocaloric diet, physical activity program, self-monitoring tools, peer group forum and monthly emails. Body weight, energy intake and physical activity were measured at week 0, week 12, week 24 and week 48. Adherence to self-regulatory behaviors was measured at week 48. Mixed model analyses were conducted to determine changes in body weight, energy intake and physical activity.

Results: A total of 203 overweight or obese young women commenced Phase I and 130 commenced Phase II. In Phase I, S group had significantly greater weight loss than G group (4.2 ± 0.6 kg vs 0.6 ± 0.3 kg, $P < 0.001$). In Phase II, both groups had significant weight loss over time without significant group differences (-0.8 ± 1.1 kg vs -0.8 ± 0.6 , $P > 0.05$). Forty-one percent (53/130) of the participants who commenced Phase II completed the internet-based intervention. Dropouts had a higher baseline BMI, were more likely to be married or in a de facto relationship, and more likely to have at least one child.

Conclusions: A self-directed internet-based program could be effective in providing support in maintaining weight loss on a structured lifestyle program in young women over 36 weeks. Further research is required to maintain engagement in young women who were married/in a de facto relationship or have children.

Keywords: Weight reduction programs; Diet; Exercise; Internet; Women's health

Introduction

Obesity is a global public health concern. The greatest weight gain in adulthood occurs in early to mid-twenties [1]. Women in this age group were twice as likely to gain weight compare with age-matched men [2]. Obesity or weight gain in young adulthood is associated with significantly increased risks of cardiovascular disease, diabetes, cancer, or premature death [3-7]. In addition to these long term sequelae, obesity also affects the reproductive and psychosocial health of young women in the short term [8-11]. Despite this, weight loss studies on this group are sparse and research is imperative to understand which approaches may be most successful.

Weight loss has been shown to improve metabolic and reproductive health [12-15]. However, long term weight management could be a considerable challenge in this group. Although many young women do attempt to lose weight [16], their commitment seems to be short-lived as young women are also more likely to drop out of weight loss

interventions [17]. It was estimated that about 20% of overweight or obese individuals in the general population are successful in maintaining at least 10% weight loss for at least a year [16,17]. The prevalence of successful weight loss maintenance in young adults is not known. Weight regain following weight loss is usually accompanied by the return of metabolic and reproductive disturbances [18].

The effect of weight loss intervention usually diminishes after the cessation of treatment, suggesting that long term intervention is required for weight maintenance [19]. However, maintaining frequent contact over long periods of time can be costly and problematic. A recent study found that the cost of developing and implementing an internet-based intervention was significantly less than an in-person and telephone-based intervention [20]. Although potentially a promising medium to deliver long-term interventions, previous studies on internet-based lifestyle modification for weight management have yielded conflicting results [21-23]. Heterogeneity among the programs and differences in their control groups makes it difficult to draw an overall conclusion on the effectiveness of internet-

based weight loss or weight loss maintenance interventions [22,23]. One meta-analysis attempted to conceptualized the different characteristics of internet-based interventions for health behaviors and found that the incorporation of behavior change techniques such as self-monitoring may increase the effectiveness of the interventions [24]. It is unclear if these would similarly enhance the effectiveness of internet-based weight management programs. Despite the large numbers of self-directed online weight management programs targeting young women, the effectiveness of this approach in young women has not been investigated.

Several long-term (>6 months) studies found that internet-based interventions were as effective as in-person interventions in weight loss or weight loss maintenance [25-27], although this was not seen in other studies [28-31]. When compared to no-intervention control, one study found that internet-based intervention was more effective in long-term weight management [32] but other studies failed to find a significant difference between the groups [33,34]. A recent meta-analysis found that whilst the Internet may have a modest effect in producing weight loss, it was not effective as a weight maintenance tool [21]. This could be due to decreasing effectiveness of internet-based program over time, such that long-term studies tend to produce non-significant weight change compared to controls [21,29,30]. The key features contributing to the success of the long-term weight management in internet-based interventions have not been clearly identified.

Most of the existing internet-based interventions required on-going involvement from healthcare professionals in reviewing online diaries, conducting chat sessions, or providing online counselling [25,26,28,29,35-37]. However, the cost of intervention is known to increase with intensity. One study found that the addition of staff consultation to a workbook and computer-based intervention increased the cost from \$0.59 to \$92.33 per participant over the 12-month study period [38]. The effect of a self-directed internet-based program with minimal ongoing staff involvement in long-term weight loss maintenance has not been extensively studied [31,39]. The primary aim of this study was to investigate the long-term effect of a structured lifestyle program delivered through a website on weight loss and weight loss maintenance in overweight and obese young women. The secondary aim was to investigate the adherence to self-regulatory behaviors in this program and to determine if these behaviors predict weight outcomes.

Methods

Subjects

Participants were women aged between 17 to 37 years who were overweight or obese (Body Mass Index, BMI>25kg/m²). Inclusion criteria included having Internet access and able to attend the clinic for in-person visits. Exclusion criteria included significant illnesses such as kidney disease, liver disease, malignancy, uncontrolled hypertension, self-reported diabetes or thyroid disease; pregnancy or lactation; or current rapid weight loss (>0.5kg/week). Participants were recruited through public advertisement. Those who were interested were asked to fill out an online screening form that assessed their eligibility for the study. Written informed consent was obtained from participants included in the study. This study was approved by the CSIRO (Commonwealth Scientific and Industrial Research Organisation) Human Nutrition and Adelaide University Ethics Committees.

Study design

In Phase I of the study, participants received either General lifestyle advice (G) or Structured lifestyle advice (S) for 12 weeks, as previously described [40] (Figure 1). In Phase II (week 13 to 48) of the study, all participants had access to a self-directed website via a unique login. The website provided information on structured lifestyle advice, which included a hypocaloric diet (1434 kcal; 40% carbohydrate, 30% protein, 30% fat) and a structured exercise program. The exercise program involved a gradual increase in physical activity to achieve 60 minutes of aerobic and resistance exercise per day as suggested for long term weight maintenance [41]. This program has been shown to result in 7-10% weight loss and improvement in reproductive and metabolic health in young women [42]. The website also included weight and waist tracker and a peer group forum. All participants also received a printed manual on the lifestyle program and electronic newsletters through email on stimulus control, coping with relapse, managing social cues, controlling negative thoughts and other related topics. The newsletters were sent every month in Phase II. Participants met with a dietitian at Weeks 24 and 48 in Phase II. Participants were encouraged to keep a food and exercise checklist daily. Meal plans were provided in the manual and on the website.

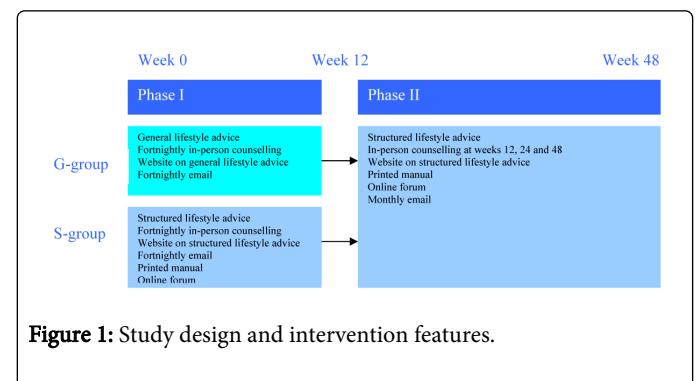


Figure 1: Study design and intervention features.

Demographic and internet-related characteristics were collected via online survey. Anthropometric, dietary and physical activity data were collected in-person at the CSIRO outpatient clinic. Data on self-regulatory behaviors and perceived helpfulness of internet-based intervention were collected via a post-intervention survey completed at the CSIRO outpatient clinic.

The primary outcomes were changes in body weight (kg), energy intake (kcal/day) and physical activity (MET-min/week). Secondary outcomes were adherence to self-regulatory behaviors.

Demographic and internet-related characteristics

Demographic characteristics such as age, marital status, education levels were obtained at week 0. Participants were also asked to provide information on their usual location for accessing the Internet for personal use, their comfort level with using the Internet, and their computer abilities.

Anthropometric assessments

Body weight was measured at week 0, 12, 24, 48 while participants wore light clothing and no shoes with the use of a calibrated electronic digital scale (Mercury, AMZ 14, Tokyo, Japan). Body height was measured at week 0 using a stadiometer (SECA, Hamburg, Germany).

Dietary and physical activity assessments

Participants completed 3-day weighed food diaries (2 weekdays and 1 weekend) at weeks 0, 12, 24 and 48 which were analyzed using Foodworks (Xyris Software 1998, Highgate Hill, Australia). Physical activity levels were assessed using the short format of the International Physical Activity Questionnaire collected at weeks 0, 12, 24 and 48 [43].

Self-regulatory behavior in weight management

Self-regulatory behaviors in weight management were obtained using a post-intervention survey. There were three questions on goal-setting (e.g. *how often did you set yourself a specific exercise goal e.g. 2 hour a week*). Response options were *I did not have specific exercise goals, less than once a month, monthly, fortnightly, weekly*. Frequency of self-monitoring was assessed in three questions (e.g. *how often did you weigh yourself*). Response options were *less than once a week, once a week, once every few days, once a day, more than once a day*. Two questions assessed lifestyle planning behaviours (e.g. *how far ahead do you usually plan your meals*). Response options were *further than a week ahead, a week ahead, one to several days ahead, on the day itself, I don't plan my meals*.

Website usage and perceived usefulness of intervention features

Website usage was quantified from website logs. Perceived usefulness of the intervention features was assessed in four questions in a post-intervention survey (e.g. *How helpful was/were the study website/monthly newsletters (emails)/forum/information on website/printed manual in supporting your effort in losing weight*). The response was a Likert scale ranging from 1 (*not helpful at all*) to 7 (*very helpful*).

Statistical analyses

Baseline differences between treatment groups and between completers and non completers were analyzed using one-way ANOVA and Chi-square tests. The attrition rate between the groups was compared using Chi-square tests. In the primary analyses, changes in body weight, diet and physical activity from week 0 to week 48 and changes from week 12 to week 48 were assessed for all participants who commenced the interventions at week 0 using linear mixed models [44]. Linear mixed models imputed the missing data based on the assumption that data were missing at random. This method has been shown to produce estimates closer to true values compared to the other conventional methods of handling missing data such as the last-observation-carried-forward method [44]. Time, group and time-by-group effects were included as fixed factors in the models. Completer's analyses were conducted using repeated measure ANOVA. Predictors of weight loss were determined using linear regression. The variables entered as predictors include age, BMI, psychological measures, internet-related characteristics, and behavioral predictors obtained in the questionnaires. All calculations were performed using SPSS for Windows 18.0 (SPSS Inc., Chicago, IL, USA). A P-value of less than 0.05 is considered statistically significant. Unless otherwise specified, all data are presented as estimated mean \pm SEM.

Results

Participants

The characteristics of participants were described in Table 1. A total of 53 participants completed the 48 week intervention (Figure 2). Attrition rate by week 48 was high (159/203; 78%) without significant differences between the groups (Table 2). At 48 weeks, completers and dropouts did not differ with baseline age, psychological distress, self-esteem, location of Internet access (i.e. home, work or other places), comfort with Internet and computer ability. However, dropouts by week 48 had higher a baseline BMI (33.9 ± 0.39 kg/m² vs 31.8 ± 0.62 kg/m², $P=0.04$), were more likely to be married or in a de facto relationship (81% of married or de facto participants dropped out compared to 67% of single participants, $P=0.024$) and more likely to have at least one child (86% of those who had at least one child dropped out compared to 68% of those who did not have any children, $P=0.007$).

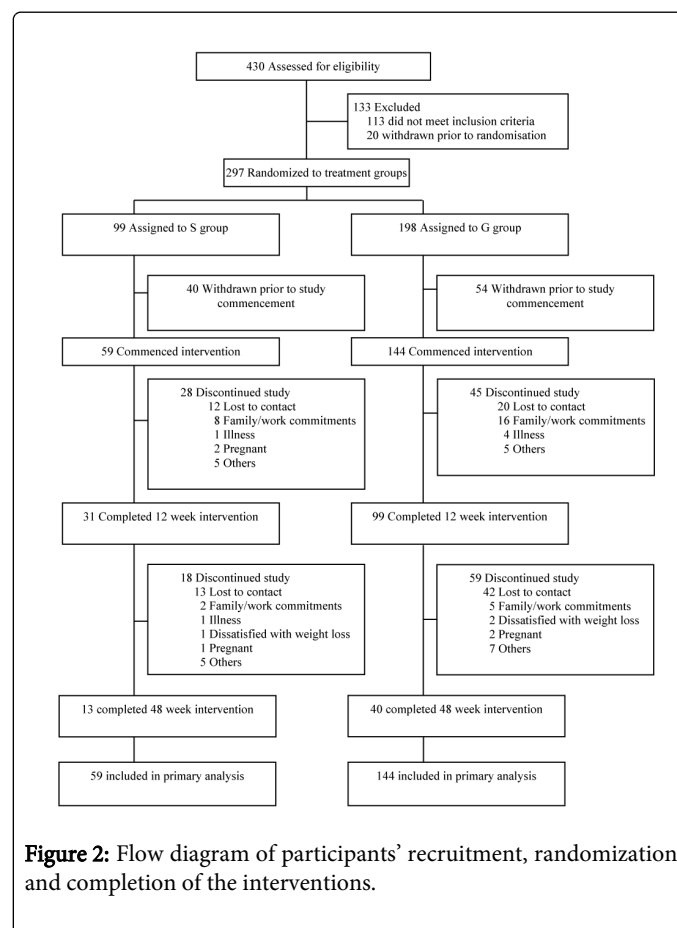


Figure 2: Flow diagram of participants' recruitment, randomization and completion of the interventions.

Body weight, energy intake and physical activity

Phase I (Week 0-12)

The results of Phase I have been previously published [40]. At the end of Phase I, S group lost significantly greater weight loss than the G group (4.2 ± 0.4 kg vs 0.6 ± 0.2 kg, $P<0.001$). There was also significantly greater decrease in energy intake in the S group compared

to the G group ($P < 0.01$) [40]. Physical activity increased in both groups without significant group differences [40].

	Means ± SE
Age, years	27.8 (0.3)
BMI, kg/m ²	33.4 (0.3)
Weight, kg	92.0 (1.0)
	%
Marital status	
Married/de facto	50
Separated, never married	50
Education	
No formal qualifications	2
High school	31
Trade/apprentice/certificate/diploma	28
University degree	39
Internet access for personal use	
Home	21
Work	72
Others	7
Internet comfort	
Comfortable	98
Undecided/uncomfortable	2
Computer ability	
Little or no experience	2
Experience with basic software applications and internet	61
Advanced understanding	28
Computer professional	9

Table 1: Baseline characteristics of participants (n=203).

Phase II (Week 12-48)

In Phase II, mixed model analysis found that weight decreased over time (week 12-48) without significant differences between the groups (-0.8 ± 1.1 kg vs -0.8 ± 0.6 kg, Table 3). There was a significantly greater decrease in energy intake (-106 ± 88 kcal/day vs 427 ± 153 kcal/day, Table 3) and a significantly greater increase in physical activity (1051 ± 518 vs 341 ± 941 , Table 3) in the G group compared to the S group during this phase (Table 3). Completers analysis found no significant time-by-group effects for body weight ($P=0.36$) and physical activity ($P=0.17$) but significant time-by-group effect was seen for energy intake with greater decrease in the G group ($P=0.04$).

Phase I and II (Week 0-48)

By the end of the intervention (at week 48), mixed model analysis found that the S group had significantly greater weight loss from week 0 compared to G group (-4.8 ± 0.8 kg vs -1.3 ± 0.4 kg, Table 3). However, S group had a significantly smaller decrease in energy intake (-206 ± 170 kcal/day vs -413 ± 101 kcal/day, Table 3) and smaller increase in physical activity (635 ± 882 MET-minutes/week vs 1219 ± 502 MET-minutes/week, Table 3) from week 0 compared to the G group. Completers analysis similarly found significantly greater weight loss in the S group from week 0 compared to G group ($P=0.01$) but no significant group differences were seen for energy intake ($P=0.08$) and physical activity ($P=0.85$).

Adherence to self-regulatory behaviors in weight management

Most of the participants who completed the intervention reported having a specific weight loss, diet and physical activity goals (Table 4). About half of the participants weighed themselves at least once a week. Most of them did not monitor their diet and physical activity (Table 4). About half of the participants planned their meals and physical activity ahead of time. None of these behaviors predicted weight change.

	S group	G group	P-value between groups
Week 0 to Week 12	28/59 (48%)	45/144 (31%)	0.036
Week 12 to Week 48	18/31 (58%)	59/99 (60%)	0.520
Week 0 to week 48	46/59 (78%)	104/144 (72%)	0.483

Data presented as participants n (%). Differences between groups were evaluated using chi-square tests

Table 2: Attrition by treatment condition over time.

Website usage and perceived usefulness of intervention features

Twenty-eight percent of the participants who received a unique username and password logged onto the website for structured lifestyle advice. Perceived usefulness of the intervention features reported by completers were as presented in Figure 3.

Discussion

Past studies on the effectiveness of internet-based interventions for long-term weight loss or weight loss maintenance have shown inconsistent results. In this study, we found that a self-directed internet-based weight management intervention maintained a modest but significant weight loss in overweight and obese young women over 36 weeks following 12 weeks of in-person intervention with website support. However, attrition was high over the 48 weeks especially among those who were married/de facto or had children. Adherence to self-regulatory behaviors such as goal setting, self-monitoring and action planning was moderate and did not predict weight outcomes.

	Week 0	Week 12	Week 48	Time effect (Week 12-48)	Time-by-group interaction (Week 12-48)	Time effect (Week 0-48)	Time-by-group interaction (Week 0-48)
Weight, kg							
S group	91.1 ± 1.9	86.8 ± 1.9	86.2 ± 1.9	0.007	0.24	P<0.001	<0.001
G group	92.4 ± 1.2	91.8 ± 1.2	91.1 ± 1.2				
Energy intake, kcal/day							
S group	2063± 71	1386± 97	1857± 157	0.15	0.009	P<0.001	0.005
G group	2028± 45	1710± 55	1612± 92				
Physical activity, Met-min/week							
S group	1971 ± 398	2291 ± 506	2606 ± 811	0.029	0.022	P=0.017	0.020
G group	2072 ± 258	2426 ± 290	3292 ± 449				

Data presented as estimated mean ± SE. Missing values imputed by linear mixed models from available data. Models included time, treatment and time-by-treatment as fixed factors (n=203; S group, n=99, G group, n=31).

Table 3: Weight, dietary intake and physical activity by treatment condition.

	Weight	Diet	Exercise
Goal setting			
None	33	22	18
Less than once a month	20	22	14
Monthly	22	10	6
Fortnightly	14	12	10
Weekly	10	33	51
Self-weighing			
Less than once a week	47	NA	NA
Once a week	27		
Once every few days	16		
Daily	10		
More than once a day	0		
Self-monitoring by diary			
None	NA	57	76
Less than once a week		25	10
Once a week		4	4
Once every few days		2	2
Daily		12	8
Planning			

None	NA	6	14
On the day itself		40	37
One to several days ahead		33	31
A week ahead		18	14
Further than a week ahead		2	4

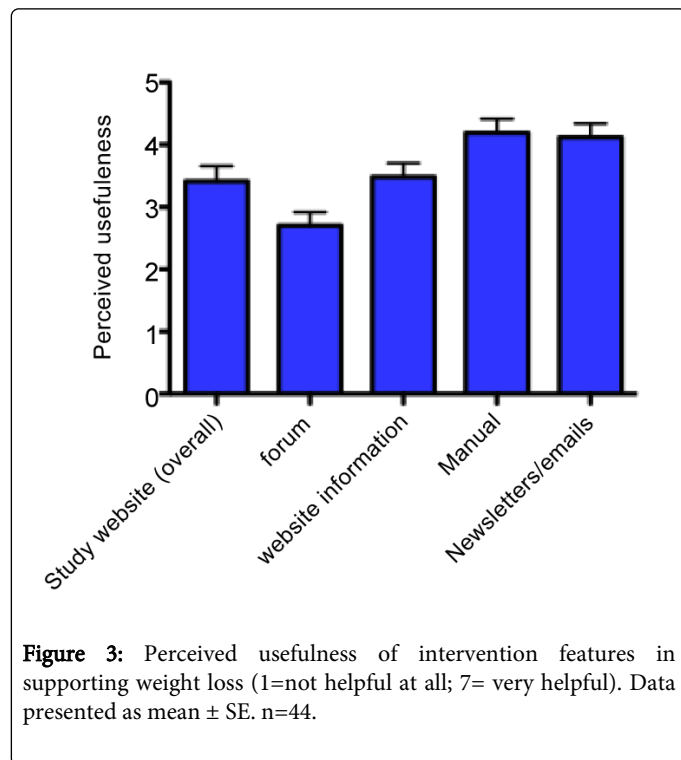
Data presented as % (total n=49).

Table 4: Adherence to self-regulatory behaviours.

Weight loss maintenance

Participants had a modest but significant weight loss (-0.8) in Phase II without group differences. While further weight loss was sometimes seen in internet-based weight maintenance studies [25,27], weight regain is more commonly seen by other internet-based maintenance conditions following weight loss treatment [26,28-30,33]. The current observation of this intervention conducted through a self-directed website successfully maintaining weight loss or preventing weight gain in this group may be clinically significant. Young women represent a high-risk group for weight gain, with an average weight gain of 0.67 kg/year for women in Australia aged 18-23 years old [10,45]. Weight gain in young adulthood is an independent risk factor for a number of chronic diseases including coronary heart disease, diabetes, cancer, kidney stone formation, and adult-onset asthma [3-7]. Weight loss, on the other hand, has been shown to improve metabolic, reproductive and psychological health in young women [12-15,46,47]. In the current study, S group maintained a greater weight loss by 48 weeks. This was likely due to greater weight loss achieved in Phase I as weight

changes did not differ between the groups in Phase II. This is consistent with previous findings in which the pattern of weight regain was similar despite differences in initial weight loss achieved, so that the long-term weight loss achieved was in favour of those who had greater initial weight loss [48]. This finding provides support for intensive interventions in the weight induction phase for greater initial weight loss.



Energy intake and physical activity

The G group reported greater decrease in energy intake and greater increase in physical activity from week 12 to week 48. Despite this, their weight loss over this period was not greater than S group. This suggests a preferential mis-reporting of energy intake and physical activity by G group. At week 12, G group had a significantly greater BMI than S group. It is known that those with greater BMI are more likely to underreport their energy intake [49].

Adherence to self-regulatory behaviors and prediction of weight loss

Interventions that combined self-monitoring with other self-regulatory skills such as goal setting and action planning were found to be significantly more effective than other interventions [50]. The National Weight Control Registry also found that self-monitoring of body weight was one of the behaviors of successful weight loss maintainers [16]. However, long-term adherence to these behaviors in a free-living population, particularly among young women, is not well known. Certain functions on the website such as weight tracking device may facilitate self-monitoring behaviors. Some internet-based studies reported that self-monitoring such as the use of weight log or food and exercise diary correlated with weight change [22,26,51]. Participants in these studies were required to submit weight or self-monitoring diaries at regular intervals. Prompts, incentives or

disincentives were employed to ensure they comply with these behaviors. In the current study, participants were encouraged but not required to engage in self-regulatory behaviors such as goal setting, self-monitoring and action planning. We found that very few maintained these behaviors over time and the frequency of engaging in these behaviors did not predict weight outcomes, although our small sample may have prevented us from detecting a significant relationship between these behaviors and weight outcomes.

Attrition

Engagement of participants is a key challenge in long-term weight management interventions. Attrition in long-term (>6 months) internet-based weight management interventions ranged from 4% [32] to 69% [52]. Most long-term studies that compared Internet and in-person interventions found no significant difference in attrition between the groups [25-28,31], except for one that reported that Internet group had higher attrition than face-to-face group in an 18 month weight maintenance program [29]. It is unclear if the high attrition rate in the current study was due to Internet delivery, although the high attrition rate in the in-person phase (Phase I) suggested that other factors might be accountable. Younger participants have been known to be more likely to drop out from in-person [53] as well as from internet-based interventions [26]. The current study had the youngest mean age (<40) compared to the other internet-based interventions of similar duration [25-35,39,52], which may explain the higher attrition rate. We also observed higher attrition in the S group that received a structured behavioral program, compared to the G group provided with general lifestyle advice in Phase I. Gold et al. [39] had also reported a slightly higher attrition rate for a structured behavioral weight loss website (VTRIM) compared to a commercial weight loss website (eDiets) at 12 months although this did not reach statistical significance (35% vs 23%) [39]. We attempted to investigate the characteristics of those who dropped out of the intervention and found that education, internet access, internet ability and internet comfort did not predict attrition in this study but women who were partnered or had children were more likely to drop out. Women, especially those who were partnered or have children, were more likely to report greater perceived time-pressure [54]. In addition, the prioritization of children's needs and the desire to accommodate food preferences of family members were also cited by young women as barriers to lifestyle modification [55].

Website usage and perceived usefulness of intervention features

In the current study, the self-directed website was one of several features in the intervention, which also include monthly emails, a printed manual and in-person counseling. Utilization of the website was neither prescribed nor mandatory. Within such context, we found that only a small percentage of participants opted to log onto the website. Non- or low-usage has been a common observation in web-based interventions [56]. It has been proposed that one of the reasons for non usage of a particular innovation is low perceived benefits to the user [56]. In the current study, the low perceived usefulness of the website is consistent with low usage of the website, which over the course of the intervention possibly contributed to attrition.

Strengths and limitations

One of the strengths of this internet-based intervention is the involvement of young women, which is known to be a challenging

group to engage in lifestyle interventions. This study employed a structured lifestyle intervention, which included a structured diet and physical activity program with behavioral support that has been previously shown to be efficacious in short-term weight loss in young women when delivered face-to-face [40,47]. However, long-term findings in this study revealed that further development to the program is required for better retention. One of the limitations of this study was the lack of a control group. The effect of this intervention compared to no-intervention can only be inferred from general population data on weight change in young women [57]. Significantly different weight loss achieved in Phase I between the groups could also potentially confound the findings of Phase II.

Conclusions

This study found that a structured lifestyle program delivered through the Internet was efficacious in maintaining weight loss in young women. However, high attrition suggests that further research is required to engage young women especially among those who were partnered or have children. Greater flexibility within the program may be important to engage this group in the long term. Our findings suggest that the long term adherence to self-regulatory behaviors is generally poor, which may explain greater weight gain in this group. Innovative strategies enabled by recent technologies should be investigated to encourage self-regulatory behaviors in this group. We have also learnt that to engage a participant over the long term, the website has to be regularly updated to provide new, relevant and useful information to the target group. With improvements to meet the participants' needs, the internet could be a promising medium to deliver long term support in weight management.

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Conflict of Interest

The authors declared that no conflict of interest exists.

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