Two-year Follow-up of a Behavioural Weight Control Programme for Adolescents in Singapore: Predictors of Long-term Weight Loss

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Abstract

We followed up 112 obese adolescents enrolled in a weight control programme at a polytechnic institute in Singapore for two years. Theprogramme used behavioural and environmental strategies to help students make sustained changes in their diet and physical activity pattern. Of these 112 students, 71.4% lost weight compared to 60% in a comparison group of 86 obese students not in the programme. About one-third (29.5%) had achieved normal weight [body mass index (BMI) <25] with a mean weight loss of 3.3 kg among boys and 2.3 kg among girls. A stepwise multiple linear regression to determine the best combination of variables predictive of weight loss found three variables to be significantly associated with long-term weight loss: percent of weight loss in the initial 8-week intervention period; increase in exercise or physical activity following intervention, and income. These 3 variables accountedjointly for 59.5% of the variance in weight loss in males and 48% of weight loss in females. We recommend intensive efforts during the initial intervention phase to help students lose weight and strategies that can help students incorporate exercise or increased physical activity in their daily routine.

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Introduction

Obesity among children and adolescents is rising in Singapore, with its prevalence among schoolchildren aged 6 to 17 years showing an almost three-fold increase from 5.4% in 1980 to 15.1% in 1991.[1] Effective weight control programmes are needed to prevent the trend from rising further. Weight control programmes using behaviour modification, diet and exercise have been found to be more effective than those based on dietary or medical treatments.[2,3] However, studies on behavioural weight control programmes have mainly focused on short-term results, usually over a period of 8 to 12 weeks.[4-6] Fewer studies have reported long-term weight loss and these studies generally show that the majority of patients regained most of the weight they initially lost during treatment.[7,8] Such findings have led obesity-treatment experts to conclude that obesity should be viewed as a chronic condition requiring long-term supportive care. Recent studies showed that weight loss is more likely to be maintained if it incorporates strategies such as post-treatment therapist contact, social support, skills training to prevent relapses, and sustained exercise.[9,10]

In Singapore, weight control programmes have been implemented in schools and government primary health clinics since early 1990. However, there is lack of published data on the effectiveness of these programmes. Ray[11] recently reported a one-year follow-up of a weight management programme among 1128 preschool children in the primary health care clinics. 40.4% of the children had improvement in their obesity status and 20.2% had achieved normal weight.[11] However, this study did not examine the factors influencing maintained weight loss. Identification of such factors, in particular the modifiable ones, will help in the planning of more effective weight control programmes.

Data are also lacking on weight control programmes for adolescents. It is important to implement such programmes to adolescents as overweight among them leads to complications like hypertension, respiratory diseases, orthopaedic disorders, diabetes mellitus and elevated serum lipid concentrations;[12] increases long-term mortality among. men, and reduces functional status among elderly women.[13] Overweight in adolescence has also been found to affect school performance,[14] psychosocial functioning and socio-economic attain-

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ment.[15] Therefore, weight control programmes targeting adolescents would not only confer health benefits but other social and economic benefits as well.

Tertiary institutions and schools would be appropriate venues for implementing weight control programme for adolescents as there is easy access to a captive group that could be followed up. In addition, the support from peers, teachers and health staff, and the availability of exercise facilities would facilitate their efforts to lose weight.

Our earlier baseline study on first year adolescent students in a polytechnic institute in 1992 found obesity among them to be associated with a family history of obesity, lack of physical exercise, and the practice of taking supper outside home. In addition, depression, stress and boredom were important triggers to eating.[16] These findings were used to plan a weight control programme that focused on behavioural and environmental strategies to change lifestyle habits and maintain weight loss. The aim of this study was to assess the long-term effectiveness of the weight control programme and to identify factors influencing long-term weight loss.

Materials and Methods

A 2-year prospective non-randomised comparison group study was conducted in a polytechnic institute to assess the association between weight change (the dependent variable) and selected independent variables among obese students aged 17 to 21 years enrolled in a weight control programme. As it would be unethical and logistically difficult to randomise students to the intervention and control group, we used the group that did not participate in the weight control programme as a comparison group. The body mass index (BMI) was used to define obesity, in which a BMI of 25 to 29.9 was defined as mild obesity and a BMI of 30 and above as moderate obesity.[17]

The Weight Control Programme

The weight control programme, using a combined strategy of behaviour modification, nutrition education and exercise, was implemented by the first author and a team of doctors and nurses from the healthy lifestyle centre in the institute after attending a course on obesity management conducted by the Food and Nutrition Department of the Ministry of Health. Students were free to choose individual counselling or group therapy. The programme consisted of an initial treatment phase and a maintenance phase. The initial 8-week phase comprising 4 weekly sessions and 2 fortnightly booster problem-solving sessions stressed on developing the students' skills to change their eating habits and physical activity pattern. Students were encouraged to make their own decisions to make gradual changes to their diet and exercise by using self-monitoring of weight, diet and physical activity; making healthier food choices in reducing fat intake when eating out; cognitive restructuring; setting realistic goals; stimulus control; and reinforcement. They were also taught how to manage stress and resist peer pressure. Pamphlets produced by the Training and Health Education Department and the Food and Nutrition Department were distributed to all students.

The maintenance phase consisted of two problem-solving sessions held a month apart. During these sessions, students discussed ways to incorporate increased physical activity in their daily routine and cope with temptations to eat, stress and examinations. As attendance was poor due to students' lack of time and their preference for self-help written materials, we subsequently maintained contact with them by phone and mail. Individualised messages were mailed to the students 6 months and a year after the initial treatment phase to disseminate practical tips on weight loss that had been used effectively by their peers. Congratulatory messages were also sent to those who were able to maintain weight loss from our monitoring, and they were encouraged to share their experiences with their peers.

At the same time, the institute implemented new policies and made some environmental changes to foster healthier lifestyle practices. Students were encouraged to participate in sports; more water coolers were installed; and food low in fat and caloric content were coded green to help students make healthier choices. Prizes were also given to the top three students who could maintain their weight loss for a year.

Data Collection

The same questionnaire was administered to students at enrolment and at 2-year follow-up. Questions included demographic data, dietary habits, exercise frequency per week, knowledge of complications of obesity, and social support. Dietary intake information was obtained on the weekly frequency of consuming selected food categories such as fried food, fatty meat, snacks, and number of sweet drinks consumed per day. A 3-day food record of daily intake was also obtained. Baseline height and weight measurements were taken by trained nurses at the healthy lifestyle centre. Subsequently, students were asked to come weekly to the healthy lifestyle centre during the first 2 months and monthly thereafter to weigh themselves under the supervision of a nurse. After 2 years, students were contacted to report to the healthy lifestyle centre to complete the questionnaire and have their weight taken. Those who did not respond after 3 attempts were interviewed over the phone. To reduce errors from self-reporting, they were first asked whether they have a weighing scale at home. Those with a positive reply

were asked to weigh themselves then and give their weight while those without a weighing scale were asked to go to the nearest place to weigh themselves. The interviewer contacted them the next day for the weight measurements. 10% self-reported their weight. None of those in the comparison group came to the healthy lifestyle centre to weigh themselves or complete the questionnaire. Thus their height and weight measurements were based on self-reports over the phone. As they were reluctant to be interviewed over the phone they were only asked whether they had attempted to lose weight over the past two years.

Data Analysis

Statistical analyses were performed using the SPSS program. Weight loss in the group enrolled in the weight control programme was first compared with the group not in the programme (comparison group). Bivariate methods were used initially to screen each independent variable to determine any statistical association between the list of independent variables and the dependent variable: long-term weight change among students in the programme. The paired t-test was used to compare mean weight change from baseline to 2-year follow-up by selected independent variables and correlation analysis to determine associations between the independent variables and dependent variable: long-term weight change. Subsequently, multiple linear regression was used to assess the joint effects of multiple factors associated with weight change. Non-collinear variables that were statistically associated with weight change at the 5% level of significance from bivariate analysis were entered stepwise into the multiple regression model to determine the best combination of variables predictive of weight change.

Results

Attrition and Attendance Rates

All 374 first year obese students were requested to enrol in the weight control programme. Two hundred and sixteen students (55.4%) attended the briefing session and 167 (44.7%) students enrolled in the programme. Female students attended 56.5% of the assigned sessions compared to 46.7% among the males. Main reasons for non-attendance were lack of time and they did not think it necessary as they had been given reading materials. At 2-year follow-up, 112 (67.1%) of the students enrolled in the programme and 86 (54.4%) of those who did not attend the briefing and were not in the programme (comparison group) participated in the survey.

Weight Change

Students in the weight control programme and those not in the programme (comparison group) were quite similar in age (17.5 years versus 17.3 years) and mean baseline BMI (27.5 versus 28.1). However, there were more females in the weight control programme (44.6% versus 28.9%) than the comparison group.

At 2-year follow-up, a higher percentage (71.4%) of the students in the weight control programme had lost weight compared to 60% of those not in the weight control programme, although the difference was not statistically significant ($P = 0.114$). 10.7% of students in the weight control programme regained all the weight lost during the initial 8-week treatment phase. The other 17.9% did not lose weight at all or gained additional weight.

Table I shows the mean BMI and mean weight loss at baseline, 8 weeks and 2 years after the weight control programme. The overall mean BMI has decreased from 27.5 at baseline to 26.4 at 2-year follow-up with 29.5% having achieved normal weight (BMI <25). The mean weight loss at 2-year follow-up was 2.9 kg with more weight loss in males (3.3 kg) than females (2.3 kg).

Predictors of Weight Loss

Bivariate analysis showed some gender differences in factors associated with weight loss (Tables II and III). Self-monitoring of weight, number of behaviour modification techniques and income were significantly associated with weight loss in males only, while number of dietary changes, and support of friends and family were significantly associated with weight loss in females only. Factors associated with weight loss in both males and females were increased physical activity, resisting emotional cues to eat and percentage of weight loss in the first 8 weeks. For both genders, weight loss at 2-year follow-up was not significantly associated with keenness in losing weight, concern about being overweight, knowledge score on complications of obesity and number of sessions attended (not in table).

The 6 independent variables found tobe significantly associated with weight loss at 2 years but showed no

TABLE I: MEAN BODY MASS INDEX AND MEAN WEIGHT LOSS AT BASELINE, AFTER 8 WEEKS OF INTERVENTION AND AFTER A 2-YEAR FOLLOW-UP PERIOD

Subjects	Mean BMI†			Mean weight loss (kg)	
	Baseline	8-week follow-up	2-year follow-up	8-week follow-up	2-year follow-up
Total (n = 112)	27.5 ± 2.2	27.1 ± 2.3	26.4 ± 2.9	1.3 ± 2.5	2.9 ± 4.9‡
Male (n = 62)	27.5 ± 2.3	27.1 ± 2.5	26.5 ± 3.0	1.4 ± 2.8	3.3 ± 5.5‡
Female (n = 50)	27.5 ± 2.1	27.1 ± 2.2	26.4 ± 2.8	1.0 ± 2.0	2.3 ± 3.9‡

† Mean ± standard deviation

‡ Weight change from 8-week follow-up to 2-year follow-up is statistically significant $P < 0.005$.
2-year mean weight loss in males is not statistically significant from females $P = 0.276$.

BMI: body mass index

TABLE II: MEAN WEIGHT CHANGE IN KILOGRAMS AT THE 2-YEAR FOLLOW-UP PERIOD BY GENDER FOR SELECTED INDEPENDENT VARIABLES

	Males		Females		Total	
Independent variable	No. of subjects n = 62	Mean weight change (SD)	No. of subjects n = 50	Mean weight change (SD)	No. of subjects n = 112	Mean weight change (SD)
Increase in physical activity after intervention						
Yes	38	5.66 (5.02)*	26	3.69 (2.61)**	64	4.87 (4.30)"
No	24	-0.43 (4.04)	24	0.83 (4.48)	48	0.20 (4.27)
Diet						
Yes	44	3.59 (5.55)	43	2.84 (3.53)***	87	3.22 (4.16)
No	18	3.11 (5.23)	7	-0.8 1 (4.65)	25	1.97 (5.30)
Self-monitor weight						
Yes	40	4.49 (5.31)**	36	2.39 (4.18)	76	3.50 (4.89)**
No	22	1.14 (5.32)	14	2.16 (3.09)	36	1.54 (4.56)
Resisting emotional cues and triggers to eating						
Yes	28	6.16 (5.51)*	28	3.81 (3.03)**	56	4.98 (4.56)*
No	34	0.95 (4.34)	22	0.45 (4.07)	56	0.76 (4.20)
Get support of family						
Yes	16	4.82 (6.34)	17	3.86 (3.86)***	33	4.32 (5.15)***
No	46	2.78 (5.17)	33	1.54 (3.70)	79	2.26 (4.62)
Get support of friends						
Yes	15	3.93 (3.05)	21	4.12 (3.50)""	36	4.04 (3.28)***
No	47	3.10 (6.11)	29	1.03 (3.66)	76	2.31 (5.38)
Attended all sessions						
Yes	10	4.87 (4.06)	15	3.22 (2.37)	25	3.51 (3.86)
No	52	2.97 (5.79)	35	1.95 (4.34)	87	2.50 (5.34)

*P <0.001**P <0.005***P <0.05: level of significance for difference between yes and no groups; SD: standard deviation

collinearity with each other viz, initial percentage of weight loss, physical activity, income, number of behaviour modification techniques, diet changes and support were entered stepwise into the multiple regression equation to assess their joint effects on weight loss. The same 3 variables were found to be significantly associated with weight loss in both males and females (Table IV). These were percentage of weight loss in the initial 8-week treatment period, increase in physical activity and income status. The cumulative adjusted R square (R^2) for the three variables was 0.595 in males, meaning that 59.5% of the variance in weight loss were accounted for by the joint effects of initial weight loss, exercise and income. In females, the cumulative adjusted R^2 was 0.480. This means that 48.0% of the variance in weight loss in females were accounted by the joint effects of the 3 variables. In males initial weight loss was the most important single variable accounting for 33.2% of the variance in long-term weight loss. In females, initial weight loss accounted for 29.1% and physical activity 13.5% of the variance in long-term weight loss.

Discussion

At 2-year follow-up, 29.5% of students in our weight control programme had achieved normal weight and 71.4% had lost weight compared to 60.0% among those not in our weight control programme. An important limitation of this study is that the comparison group is not directly comparable to the intervention group as students were not randomised for ethical and logistic reasons. Consequently, the groups differed in gender with more girls in the weight control programme. However, both groups were quite similar in age and mean BMI.

Our finding of a high proportion (60%) in the comparison group with weight loss could be explained by the following reasons. Firstly, the majority (81%) in the comparison group reported that they had attempted to lose weight although they did not participate in our programme. Secondly, the high proportion of weight loss among them could be attributed to the public healthy lifestyle campaign, diffusion of effects from peers, and environmental changes implemented in the institute at the same time. Thirdly, there could be selection bias with respondents more likely to be those who had lost weight, although the same bias could also be found in the intervention group. Fourthly, the weight status at the 2-year follow-up period in the comparison group was

TABLE III: CORRELATIONS BETWEEN WEIGHT CHANGE AT TWO YEARS AND INDEPENDENT VARIABLES SIGNIFICANTLY ASSOCIATED WITH THE WEIGHT CHANGE

Variables	Correlation coefficient		
	Male. n = 62	Female n = 50	Total n = 112
Weight loss during the initial 8-week intervention (%)	0.61"	0.53*	0.58*
Number of behaviour† modification techniques (0-4)	0.25***	0.07	0.18
Number of changes‡ in dietary habits (0-5)	0.15	0.34**	0.18***
Fat intake score (0-2)§	0.19	0.25	0.19***
Social support score (0-2)¶	0.14	0.37***	0.21***
Increase in physical activity (No 0, Yes 1)	0.56*	0.48*	0.52***
Income¥	0.37***	0.01	0.27

*P <0.001, **P <0.005, ***P <0.05

† Behaviour modification techniques include:
1. self-monitoring of weight
2. self-monitoring of diet
3. self-monitoring of physical activity
4. resisting cues to eating

‡ Number of dietary changes include taking less in a week of the following items:
1. fatty meat
2. fried food
3. sweet drinks
4. snacks and desserts
5. supper

§ Fat intake score:
0 - did not take less fat
1 - take less fatty meat or fried food
2 - take less fatty meat and fried food

¶ Support score
0 - no support
1 - support from family or peers
2 - support from family and peers

¥ Income - monthly household income per capita

Pearson correlation coefficient used for all variables except fat intake score, social support score and physical activity in which Spearman correlation coefficient was used.

based on self-reports (compared to 10% in the intervention group) and they could have reported weight loss to prevent health staff from contacting them again. Considering that the proportion who lost weight in the comparison group are more likely to be overestimated due to the abovementioned reasons, the effectiveness of our weight control programme cannot be discounted as the proportion who lost weight in the intervention group is still higher than the comparison group.

About one-third (29.5%) of adolescents in our weight control programme has achieved normal weight. There is no local data on long-term follow-up of weight control programmes for adolescents. Our findings were comparable to a local weight control programme for preschool children where 20.2% had achieved normal weight after one year.[11] There are few studies on weight control for adolescents in the West, and they generally show low success rates ranging from no change in mean weight index[18-21] to 11% of subjects achieving a reduction in BMI of $\geq$5%.[22] Our study showed a higher success rate with 50.9% of adolescents achieving a reduction in BMI of $\geq$5%.

More importantly, the prime purpose of our study was to identify modifiable factors associated with maintained weight loss. The 2 most important predictors were initial weight loss and increase in physical activity. The greater the percentage of weight lost during the 8-week treatment phase, the greater the weight loss after a 2-year period. Our findings concur with Lavery's study on a behavioural weight control programme[23] but differ from studies on weight control programmes that used very low calorie diets. A major study on a low-calorie-diet programme showed that initial weight loss was not correlated with maintained weight loss.[24] Although there was a rapid initial weight loss of 15 kg per person in the first 14 weeks, only 4% maintained the weight loss after 2 years with the others regaining up to 82% of the initial weight lost.[24]

The other important predictor was increase in physical activity. In our study, males who exercised or increased their activity had an average weight loss of 5.66 kg compared to a gain of 0.43 kg among those who did not exercise. Our finding is consistent with other studies which found exercise to be one of the most important factor in maintaining weight loss. Following our intervention, 61.3% of the males and 50.0% of the females self-reported an increase in exercise frequency or physical activity. We were able to get students to exercise by emphasising its immediate social and psychological benefits such as decreasing stress, feeling more relaxed, looking better, being able to concentrate and study better, and feeling fit and less lethargic. Students who reported lack of time to exercise were taught time management skills and advised on how to incorporate increased physical activity in their daily routine such as coming down one bus stop earlier and continuing with brisk walking to school.

Diet and decreased frequency of fat intake were not found to be associated with weight loss after adjusting for the other factors. This could be due to our rather crude assessment of diet which was based on self-reporting of frequency of consumption of certain food categories. We were not able to analyse the mean daily dietary intake due to the poor response to this question. Studies on the role of diet in weight loss show conflicting

TABLE IV: MULTIVARIATE LINEAR REGRESSION OF SELECTED INDEPENDENT VARIABLES TO PREDICT WEIGHT CHANGE IN KILOGRAMS

Variables	Dependent variable- weight change in kilograms				
	Regression coefficient	Standard error of coefficient	*P* value	Adjusted R^2 change	Cumulative adjusted R^2
Males (n = 62)					
Percentage of weight loss during the initial 8-week intervention	0.765	0.170	0.001	0.332	0.332
Increase in physical activity (Yes 1; No 0)	5.860	1.294	0.001	0.144	0.476
Income	0.001	0.0003	0.007	0.119	0.595
Constant = -4.088					
Female (n = 50)					
Percentage of weight loss during the initial 8-week intervention	0.426	0.130	0.002	0.291	0.291
Increase in physical activity (Yes 1; No 0)	2.778	0.708	0.000	0.135	0.426
Income	0.0006	0.0003	0.037	0.054	0.480
Constant = -0.93 1					

R^2 change is the increment in variance accounted for at each step of the analysis.

results. Some studies found fat intake to be inversely proportional to relative weight loss.[25,26] Other studies showed that dieting by itself is not effective. The reasons hypothesised were as follows. Firstly, periods of restricted caloric intake may predispose an individual to subsequent binge eating.[3] Secondly, weight cycling theory has suggested that repeated bouts of weight loss and regain might result in increased metabolic efficiency, thereby making subsequent weight loss more difficult to achieve. Thus although structured energy restriction promotes weight loss, it has been proven generally to be ineffective for maintained weight loss.

Unlike other studies, we did not find an association of weight loss with the number of sessions attended.[23,27] It could be because we used other methods to maintain contact with the students such as mailed messages and this was not accounted for in computing the sessions attended.

The rather poor participation (44.7%) and follow-up rates (67.1%) were similar to other studies,[28,29] in which some reported even higher rates of recidivism. Most mildly obese students feel well and hence do not want to waste time attending weight control sessions. As shown in our study, only 31.3% reported that being overweight interfered with their daily routine. It is well established that it is an uphill task to maintain weight loss. Apart from the difficulty in making lifestyle changes and then sustaining them, weight loss also triggers physiological mechanisms, such as adaptive thermogenesis and increased production of adipose tissue lipoprotein lipase that dispose the obese person to regain weight.

As our study was conducted in a polytechnic institute, the findings cannot be generalised to the entire population of adolescents in Singapore. We also did not examine the role of personality factors and parental involvement in influencing weight loss. This could partly explain why 41.5% of the variance in weight change in males and 52% in females were not accounted for.

Conclusion

In conclusion, our behavioural weight control programme was quite effective in maintaining long-term weight loss. Important predictors associated with long-term weight loss were initial percentage of weight loss and increased physical activity. We recommend intensive efforts during the initial stage to help students lose weight gradually through behaviour modification, and strategies to incorporate increased physical activity in their daily routine. Future studies should also examine cognitive and personality factors influencing weight loss. We plan to work with a psychologist and include parental participation in the next phase of our study to improve the weight control programme. We also plan to follow-up this cohort to assess the maintenance of weight loss.

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