

Weight loss in obese women — exercise v. dietary education

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Summary

It was postulated that a nutrition-education programme was as effective an adjunct to a diet-based weight-loss programme as an exercise regimen. Forty-five obese female volunteers were placed on the same 5 000 kJ diet and were then assigned to each of three therapy groups: (i) an exercise group, involving three 1-hour exercise sessions per week (15 women); (ii) a lecture group involving a weekly 1-hour group lecture session (15); and (iii) a control group (15) who received only the diet and no activity. Weight loss, body fat loss (%) and daily energy intake reductions were equally reduced in the subjects in all three groups who completed the programme. There was, however, a significantly higher dropout rate in the control group. Taking this into account, the weight loss in the two test groups was similar and greater than that of the control group. We conclude that, in the short term, dietary education was as effective as exercise in promoting dietary compliance and weight loss.

S Afr Med J 1990; 78: 15-18.

According to the energy balance equation, for weight loss to occur the energy intake must be exceeded by the energy expenditure. At present preference in the treatment of weight loss is the combination of exercise with a kilojoule-restricted diet in order to promote a negative energy balance and therefore cause weight loss.¹⁻³ An added advantage of exercise therapy is that fat loss, as opposed to loss of lean body mass, is apparently favoured.^{4,5}

Behavioural therapy is also an important aspect of weight loss; as early as 1953, Brosin⁶ suggested that obesity is 'amenable to ordinary manipulative therapies, including social clubs modelled upon Alcoholics Anonymous'. More recently, Jeffery and Wing⁷ reported that frequent contact between the therapist and the overweight person promotes weight loss, while Burbach and Schomer⁸ suggested that 'the supportive nature' of their study programme facilitated the maintenance of a kilojoule-restricted diet under times of emotional stress.

A study was carried out in order to determine whether regular group exercise or behaviour modification through dietary education was a superior adjunct to a diet-based weight-loss programme.

Subjects and methods

Consequent upon approval by the Ethics Committee of the University of Stellenbosch, 200 informed women with a body mass index (BMI) greater than 30 volunteered to participate in a 16-week study. In order to optimise compliance, only subjects

who declared their willingness to be assigned to any one of the three following groups were selected: (i) diet plus exercise; (ii) diet plus lectures; and (iii) diet only. Fifteen subjects were then randomly selected for each of the above three groups, so that age and BMI were similar (Table I).

TABLE I. AGE, HEIGHT, WEIGHT AND BMI FOR THE THREE GROUPS IN THE STUDY (MEAN ± SEM)

	Exercise (N = 13)	Lectures (N = 15)	Control (N = 8)
Age (yrs)	37,2 ± 1,8	38,4 ± 1,8	37,4 ± 1,6
Height (cm)	163 ± 2	165 ± 2	165 ± 3
Weight (kg)	92,5 ± 4,4	95,6 ± 4,2	93,9 ± 5,4
BMI (kg/m ²)	34,58 ± 1,61	34,81 ± 1,32	34,25 ± 1,28

All subjects underwent a medical examination to exclude smokers and subjects with contraindications for participating in an exercise programme, e.g. cardiac arrhythmias or organic cardiac disease.

The exercise group followed a carefully graded, supervised, aerobic exercise programme,⁹ attending three 1-hour sessions per week for the 16-week period. Sessions consisted of stretching (6 - 8 minutes) followed by 30 minutes of aerobic exercise (walking/jogging) at an intensity calculated to maintain the heart rate at 70% of the predicted maximum for at least 20 minutes. Pulse rate was measured by subjects at random intervals during the exercise period in order to maintain an appropriate exercise intensity. Exercise sessions were concluded with strengthening exercises (14 - 18 minutes) and final stretching exercises (6 - 8 minutes).

The diet group attended weekly lectures on nutrition, with the emphasis on 'healthier' eating habits, identifying 'poor' habits and their causes, and substituting constructive alternatives for behaviour-orientated eating habits.⁶

The control group received dietary prescription only and did not participate in any group activities.

All subjects were prescribed the same 5 000 kJ reducing diet, based on essential daily portions and food exchange groups. Groups 1 and 2 were weighed weekly in the laboratory; the control group recorded their weight at home. The latter readings were verified once a month on our laboratory scale.

Compliance with the diet was assessed using detailed 24-hour recall and quantified food frequency questionnaires completed every 4 weeks with the assistance of the same dietician. For the 24-hour recall questionnaire, the time of day the food was consumed and the type, amount and method of preparation were recorded. Food composition tables¹⁰ and portion-size guidelines¹¹ were used to analyse and monitor energy intake. For the food frequency questionnaire, the type and amount of food eaten during and between meals and the frequency of the intake of the food over a period of 1 week or 1 month was calculated, and the average intake per day accordingly determined. Daily energy values for both methods were then averaged and taken as representative of average daily energy intake.

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Body circumferences, using standard sites and techniques,¹⁰ were measured at the start and end of the programme. Using abdomen, thigh and calf circumferences, percentage body fat was then estimated according to the formula of Katch and McArdle.¹²

Physical fitness was assessed using an incremental treadmill exercise test to exhaustion. Following a short orientation walk on the treadmill, subjects started exercising at 5 km/h and 0% grade for 3 minutes; the grade was then increased from 0% to 5% for the next 3 minutes, followed by 1 km/h speed increases every 3 minutes to voluntary exhaustion.

Mixed expired gases were dried with calcium chloride and analysed continuously using a Morgan Oxygen Analyzer OA500D and a Morgan high-speed response infra-red carbon dioxide analyser (901 MK2). Inspiratory minute ventilation was measured with a Morgan Ventilometer Mark 2, while an ECG trace and heart rate measurement were obtained using Simonsen and Weel monitors (SCR 108 and MTS 216). Test data were averaged every 10 seconds and collected and stored using a Morgan exercise software package. All instruments were calibrated within 30 minutes of the commencement of each test. Since an oxygen consumption (VO_2) (l/min) plateau was seldom attained, we defined and identified the peak VO_2 as the highest VO_2 reading obtained over any 10-second period.

In the statistical analysis of the data, the Wilcoxon matched-pairs signed-rank test was used for comparisons within groups, while the Mann-Whitney *U*-test was used for inter-group comparisons. All data in the text are given as the mean \pm standard error of the mean, and relate only to subjects who completed the 16-week study.

Follow-up study

Subjects were followed up 1 year after completion of the initial study. To reduce the possibility of rapid weight loss immediately before re-evaluation, subjects were telephoned 1 week before the assessment.

All the original tests were then repeated under identical conditions, and the results were compared with the initial and final values obtained in the original programme using the Wilcoxon matched-pairs signed-ranks statistical test.

Results

Of the 45 subjects who started the project, 36 completed the

16-week course: 2 subjects became pregnant and were withdrawn from the exercise group, while 7 subjects 'absconded' from the control group and were lost to the study. There were no withdrawals from the lecture group.

The highly significant decrease ($P < 0,01$) in body mass, BMI and, consequently, in body fat % that occurred in all three groups was associated with similar reductions ($P < 0,01$) in average daily energy intake (Table II).

Fig. 1 illustrates the average daily energy intake recorded monthly for the three groups. Within the first month of the study, daily energy intake was significantly reduced ($P < 0,01$) in all three groups, and this reduction was maintained for the duration of the study. Although there were minor variations in monthly values, percentage changes remained similar in all three groups at all stages of the study.

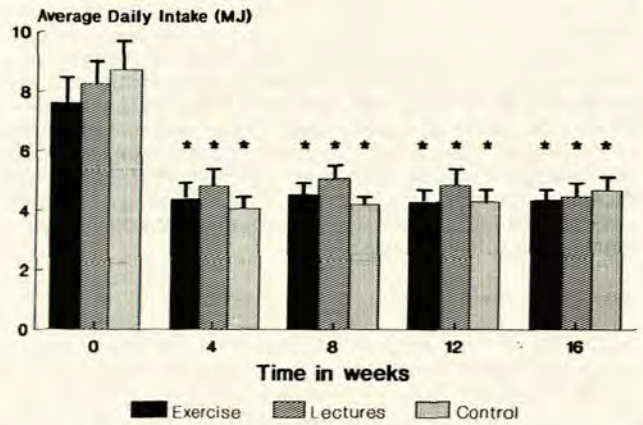


Fig. 1. Average daily kilojoule intake was evaluated monthly for each group (*indicates values are significantly different ($P < 0,01$) from starting values).

Peak VO_2 , expressed in ml/kg/min or in ml/kg lean body mass/min, was significantly increased in all three groups but, taking into account the significant decrease in body mass which would prejudice VO_2 changes, results were preferentially expressed in l/min. In this case, peak VO_2 (l/min) was significantly increased ($P < 0,01$) in the exercise group only (Table III).

TABLE II. BODY MASS, BMI, BODY FAT % AND AVERAGE DAILY INTAKE FOR THE THREE GROUPS AT THE BEGINNING AND END OF THE STUDY (MEAN \pm SEM)

	Exercise (N = 13)	Lectures (N = 15)	Control (N = 8)
Body mass (kg)			
Start	91,5 \pm 4,5	94,5 \pm 4,0	96,6 \pm 4,4
End	84,5 \pm 4,2 *	86,4 \pm 3,8 *	87,3 \pm 4,5 *
BMI (kg/m²)			
Start	34,58 \pm 1,61	34,81 \pm 1,32	34,25 \pm 1,28
End	31,79 \pm 1,48*	31,79 \pm 1,27*	30,85 \pm 1,18*
Body fat (%)			
Start	38,0 \pm 0,8	38,3 \pm 0,6	40,1 \pm 0,4
End	29,4 \pm 1,6 *	32,4 \pm 1,6 *	30,2 \pm 1,5 *
Average energy intake (kJ/d)			
Before	7 926 \pm 701	8 249 \pm 755	8 480 \pm 955
Start	4 473 \pm 265 *	4 807 \pm 367 *	4 224 \pm 355 *
End	4 538 \pm 307 *	4 453 \pm 272 *	4 798 \pm 384 *

* Significantly different ($P < 0,01$) from starting values.

TABLE III. VO_2 FOR THE THREE GROUPS AT THE START AND END OF THE STUDY (MEAN \pm SEM)

	Exercise (N = 13)	Lectures (N = 15)	Control (N = 8)
VO_2 peak l/min			
Start	1,89 \pm 0,10	1,96 \pm 0,11	1,95 \pm 0,14
End	2,39 \pm 0,12*	2,04 \pm 0,13*	1,99 \pm 0,09*
VO_2 peak ml/kg/min			
Start	20,62 \pm 0,90	20,87 \pm 0,95	20,74 \pm 1,18
End	28,45 \pm 2,01*	26,00 \pm 1,40*	23,13 \pm 1,09†
VO_2 peak ml/kg lean body mass			
Start	31,29 \pm 1,69	32,06 \pm 1,43	31,53 \pm 2,20
End	40,38 \pm 1,69*	38,49 \pm 1,91*	33,54 \pm 1,62†

*Significantly different ($P < 0,05$) from starting values.†Significantly different ($P < 0,01$) from starting values.

Follow-up study

Unfortunately we were only able to re-test 12 of the 36 subjects who completed the original study; 18 of the remaining 24 were unable to participate either because they had changed residence or because they were employed and unable to attend re-evaluation sessions. The remaining 6 subjects admitted to having gained weight, and refused to participate in the follow-up study. All 6 of these subjects were from the control group.

Of the 12 subjects re-tested, 3 were from the exercise group, 7 from the lecture group, and 2 from the control group. Since numbers were insufficient for group comparisons to be conducted, subjects were used as their own control with follow-up results being compared with starting and final values of the initial study.

Table IV summarises the results obtained for the follow-up group. Body mass, body fat and average daily energy intake were all significantly reduced at the end of the original 16-week project. Although there was a slight, non-significant increase in all these parameters 12 months after completion of the initial study, they remained significantly lower than values obtained at the start of the study.

With respect to weight loss, only 3 of the 12 studied weighed more than their original weight, and were therefore classified 'failures' with respect to long-term weight-loss or weight-maintenance. The remaining 9 were classified long-term 'successes', since 5 had maintained their reduced weights as measured at the end of the initial programme, and 4 had continued to lose weight. The overall long-term success rate for the original group was 21% (9/43), and for those who completed the initial study 25% (9/36).

Peak VO_2 (l/min) was also significantly increased at the end of the 16-week study, mainly due to the marked increase (28%) in the peak VO_2 of the exercising subjects. One year later peak VO_2 had decreased slightly (but not significantly), and remained significantly greater than the original starting peak VO_2 values.

Of those subjects who were followed up, all the exercise-group subjects had maintained the exercise programme, while 4 of the lecture-group subjects had subsequently included regular exercise as part of their weight control programme. None of the control-group subjects participated in a regular exercise programme.

Discussion

Body mass, and consequently BMI, decreased by 8% in the exercise group, by 9% in the lecture group and by 10% in the control group. However, only 8/15 of the control group completed the project, a dropout rate of 47%, which is similar to the 50 - 70% 'attrition' rate found by Volkmar *et al.*¹³ Since the average weight loss for the absconders was 0,5 kg when they dropped out one can safely assume that they withdrew as a result of negligible weight loss. In this case, the average weight loss for the original control group is only 5%, which is significantly lower than the weight loss for the other two groups. Since there were no absconders from either the exercise or the lecture groups, we conclude that the interpersonal contact obtained and/or behavioural-modification achieved by these two groups played an important role in maintaining interest and promoting dietary compliance. It must be remembered, however, that there remained a small subgroup of highly motivated control subjects for whom dietary self-control as the only method of weight loss was both appropriate and successful.

The effectiveness of the exercise programme was indicated by the mean increase in peak VO_2 of 28% attained by the exercise group after 16 weeks of aerobic exercise training. According to the correlation between resting metabolic rate and $\text{VO}_{2\text{max}}$ found by Lennon *et al.*,¹⁴ a 12% increase in $\text{VO}_{2\text{max}}$ is associated with a significant increase in resting metabolic rate; hence the 28% improvement in the VO_2 peak recorded in

TABLE IV. RESULTS FOR THE FOLLOW-UP STUDY, SHOWING ORIGINAL STARTING VALUES, VALUES OBTAINED AT THE END OF THE ORIGINAL 16-WEEK STUDY, AND VALUES OBTAINED 12 MONTHS AFTER COMPLETION OF THE STUDY (MEAN \pm SEM)

	Start (N = 3)	End (N = 7)	Follow-up (N = 2)
Body mass (kg)	95,6 \pm 3,4	87,8 \pm 3,3*	88,4 \pm 4,0*
Body fat (%)	45,5 \pm 1,9	39,5 \pm 2,2*	38,7 \pm 1,0*
Average energy intake (kJ/d)	8 138 \pm 953	5 061 \pm 330*	5 385 \pm 593*
Peak VO_2 (l/min)	1,98 \pm 0,13	2,43 \pm 0,12	2,37 \pm 0,15

* Significantly different ($P < 0,01$) from starting values.

our study might be expected to be associated with an increased daily energy expenditure. One would, therefore, expect the weight loss in the exercise group to be greater than in the other groups. This, however, was not the case, since body mass and body fat % were equally and significantly reduced in all three groups (subjects who completed the course). These results concur with those of Van Dale *et al.*¹⁵ who found that a combination of diet and exercise did not improve weight loss when compared with a diet group only. It may be that the decreased resting energy expenditure due to dieting¹⁶ nullified or prevented the increase that could be expected as a result of the regular exercise. This suggestion concurs with Henson *et al.*¹⁷ who, since the initiation of our study, have reported that exercise that significantly increased $\text{VO}_{2\text{max}}$ in moderately obese women did not reverse the dietary-induced depression of resting energy expenditure.

While it may be suggested that our method of estimating body fat % is not sensitive enough to identify changes, Katch and McArdle¹² found that % body fat measured in this way was within 2,5 - 4,0% of values determined by underwater weighing. For our very obese subjects, we found this method to be more precise, in respect of reproducibility, than using skinfold measurements. Body fat loss was equal in all three groups (subjects who completed the programme), and probably accounted for most of the general weight loss in all subjects. There was thus no evidence that additional fat loss was promoted by exercise. Average daily energy intake was also equally and significantly reduced (40%) in all the study groups, with the similarity of these group results suggesting that the restricted intake was primarily responsible for the general weight loss as well as the fat loss. The average weekly weight loss of 0,5 kg was lower than the 1 kg/week recorded by Van Dale *et al.*¹⁵ but they prescribed a 3000 kJ diet as opposed to our 5000 kJ diet.

Follow-up study

The fact that body mass, body fat and average daily intake recorded in the follow-up study remained significantly lower than the original starting values suggests that, on average, the project had been successful in 25% of the subjects who completed the initial study. This success rate is significantly higher than the 5 - 10% predicted by Walker.¹⁸ More specifically, however, since there were no long-term successes from the control group, we conclude that long-term behavioural alteration in respect of eating habits and maintenance of a reduced dietary intake was promoted by a 16-week period of interpersonal contact/behaviour-modification, whether in the form of lectures or regular aerobic group exercise.

In addition, the constancy of peak VO_2 suggests either that the exercise group continued to exercise or that the lecture subjects instigated exercise as part of their weight-loss or weight-maintenance programme. In fact, both explanations were valid since the exercise group retained their exercise habits, and 4 of the lecture group had begun an exercise programme on their own initiative after completion of the initial programme. The slight but insignificant decrease in peak VO_2 , however, resulted from the marked decrease in peak VO_2 of the 2 control subjects who gained weight over the 12-month follow-up period.

Conclusion

On first examination, the major finding of this study appears to be that neither regular interpersonal contact nor regular aerobic exercise promoted additional weight loss when compared with results obtained for subjects on a kilojoule-restricted diet only (control group). If, however, the drop-out rate of the control group is taken into account, the exercise and lecture groups have a greater weight loss in both the short and the long term.

We conclude, therefore, that although there is a subgroup of highly motivated obese individuals for whom dietary self-control as the sole weight loss method is effective, interpersonal contact and behavioural modification — in the form of regular lectures or exercise sessions — is important in promoting dietary compliance, weight loss in general and fat loss in particular. Since this dietary self-control is effective in the short term only, regular contact in an initial (16-week) programme plays an important role in modification and long-term maintenance of appropriate dietary and, possibly, exercise behaviour.

Finally, although exercise promoted fitness, it did not have an additional effect on total weight or fat loss. We conclude, therefore, that weekly lectures on nutrition-related topics are as effective as tri-weekly exercise sessions in facilitating both weight and fat loss.

The authors gratefully acknowledge the financial assistance provided by the South African Sugar Association.

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